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Soviet Plans and Prospects for Reducing Oil Use in the Electric Power Industry

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A Research Paper

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Soviet Plans and Prospects for Reducing Oil Use in the Electric Power Industry [redacted]

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A Research Paper

This paper was prepared by [redacted] the Office of Soviet Analysis, with contributions by [redacted] the Office of Imagery Analysis. Comments and queries are welcome and may be directed to the Chief, Economic Performance Division, SOVA, on [redacted]

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Soviet Plans and Prospects for Reducing Oil Use in the Electric Power Industry [redacted] 25X1

Summary

Information available as of 1 January 1985 was used in this report.

Moscow's hopes of sharply reducing oil consumption in the power industry will be frustrated at least through 1985 and possibly until the early 1990s. Programs to build gas-fired power plants, expand gas distribution systems, and convert power plants to gas have been largely successful. Oil use, however, probably will not decrease until 1990 or later. Before then, most of the increase in supply of gas to the power industry will be needed to offset shortfalls in the coal supply and to support above-plan electricity generation at many thermal power plants.

Oil use by the power industry became an important issue in the 1970s when it more than doubled, making oil the leading fuel. Moscow first called for the replacement of oil by coal at new power plants, but by the late 1970s this policy was overtaken by shortfalls in coal production and by the promise of gas-for-oil substitution. The Soviets now view natural gas as the fuel that will displace oil, at least through the mid-1990s.

Outlook for 1985

The 1981-85 plan set a goal for reducing use of oil products (residual and diesel fuel oils) at power plants by about one-half million barrels per day in terms of crude oil equivalent (b/doe) in 1985. We estimate, however, that in 1985 power industry oil use will remain at about 2.5 million b/doe, unchanged from the 1980 level. Our projections suggest that, under conditions less favorable than those underlying this estimate, oil use could increase by up to 150,000 b/doe in 1985. A reduction in oil use of up to 250,000 b/doe is possible but not probable. For the maximum reduction to occur, the power industry's total fuel demand would have to be curtailed sharply, coal supplies boosted, and efforts to maximize gas use almost totally successful—all before yearend 1985.

In 1985, gas use at power plants will probably be about 50 percent higher than in 1980, reaching roughly 177 billion cubic meters—about 28 percent of our projection for total Soviet natural gas production. We estimate that power plant conversion to gas from coal or oil will absorb about 40 percent of the total increase in power industry consumption of natural gas, that new demand from gas-fired power station startups will take 35 percent, and that the remaining 25 percent will go to power plants that increase their use of gas as a backup fuel.

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Prospects for 1990

In their 20-year energy program published in March 1984, the Soviets announced goals for cutting power plant oil use by about 1 million b/doe by 1990. We judge that this goal is out of reach, even under the most favorable circumstances. Our projections indicate that oil use in the electric power industry could be lowered by as much as 720,000 b/doe by 1990. Savings of this magnitude would require during 1981-90 an increase in coal supplies to the industry of 40-45 million tons and a boost in gas supplies of about 123 billion cubic meters. At the same time the growth of organic-fuel consumption to provide electricity and cogenerated heat would have to be held at or below an average annual rate of 2.1 percent. To achieve the 720,000-b/doe oil reduction, the Soviets must rapidly boost output of the now-stagnant coal industry, eliminate virtually all constraints to gas usage in the power industry, speed up construction of nuclear power plants, and accelerate improvements to fuel-use efficiency. We do not expect the Soviets to succeed in changing the structure of power industry fuel use so rapidly.

Rather, we project a decline in power industry oil use of only about 275,000 b/doe between 1980 and 1990—with the power industry's coal supply growing by some 25 million tons, gas use increasing by about 110 billion cubic meters, and growth of power plant demand for organic fuels slowing to about 2.2 percent annually as the share of nuclear power becomes larger. Even this modest progress in changing the power industry's fuel mix could be placed in jeopardy by unfavorable developments. For example, a demand for up to 170,000 b/doe more oil in 1990 than in 1980 could result if, *simultaneously,* the coal industry failed to increase supplies, the rate of conversion of plants to gas use does not rise above the current level, and nuclear power plant construction fails to accelerate.

Critical Constraints

We consider coal supply to be the most important variable in the power station fuel-use equation. Coal availability is an important though indirect determinant of power industry use of oil because many coal-fired plants burn backup stocks of oil when coal supply is inadequate. The coal supply issue has particular relevance, not only because of the large amount of coal-based capacity on line and under construction but also because of the clouded outlook for both the quantity and the quality of coal available. We expect that the Soviets will fail to overcome the problems plaguing coal production during the remainder of the 1980s. The Ministry of Power and Electrification will therefore need to curtail sharply plans to build new

coal-fired power plants and to redesign existing plants to burn gas, or else face increased oil consumption or more disruptions in the supply of electricity. The outcome will probably be a combination of these alternatives, given the large amount of coal-based capacity under construction and the time-consuming nature of fuel redesign.

The large number of power stations capable of burning oil and the need to keep them operating to meet electricity demand are other obstacles to saving oil in the power sector. Almost 85 percent of the thermal power plant capacity in the USSR can use oil, even though only 10 percent relies solely on oil. Oil-capable generating capacity is pressed into service to offset shortfalls in other fuel stocks, particularly coal. Moreover, when power systems must compensate for below-plan output at hydro and nuclear stations, oil is frequently the only fuel available.

The track that the Soviets have followed in converting power plants to gas from other fuels has also limited oil savings. The current plan for conversion puts top priority on using gas to eliminate the use of oil as a backup fuel at coal-fired power plants; direct substitution of gas for oil at oil-fired plants has been given a lower priority. Although this kind of conversion can offset coal shortfalls and cut consumption of backup oil, the reduction in oil use will be less than could be achieved if all the gas were substituted in power plants that burn only oil. Moreover, reluctance to take the largest power plant boilers off line for conversion and delays in constructing gas distribution lines have been and probably will continue to be a drag on the expansion of the use of gas in the electric power sector. Taking these factors into account, we expect the Soviets to be able to shift about 10 percent of the power industry fuel consumption to gas by 1990.

Implications for the Soviet Economy

In our view, the most likely trends in power industry fuel use imply:

- Delayed expansion of secondary oil refining. Power plant demand for residual fuel oil will continue to exceed Soviet plans—thereby reducing the availability of residual oil for cracking to increase supplies of gasoline and diesel fuel.

- Reduced exports of fuel oil or more valuable refined products "saved" at power plants. The slow progress in reducing oil use will limit such sales to less than 30 percent of the prospective $10 billion that could be earned annually by 1990 if goals for oil savings were achieved.

- Some brake on the growth of Soviet production and consumption of gas. Because the power industry is by far the leading gas consumer, maintaining the growth of gas production after the mid-1980s will require the dedication of more resources to increasing power plant gas use or to adding major new gas consumers in other economic sectors.

The changes under way and planned in the power industry's fuel supplies may well aggravate disruptions in electricity supply. A greater incidence of power shortages, brownouts, and substandard electricity supply is likely because there is little reserve capacity to bring on line when plants are out of service during fuel conversion. Although electricity supply is likely to be taut for the foreseeable future, increased use of gas should eventually reduce those power interruptions stemming from inadequate supply of fuel.

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Preface

Long before the possibility of a leveling off or decline in the USSR's oil production was discussed openly in the Soviet press and technical journals, the power industry adopted programs to radically restructure its fuel consumption. Oil consumption was to be sharply reduced, coal use was to increase, and—under the most recent programs—natural gas usage was to grow rapidly. As the possibility of a decline in oil output became an issue, Soviet energy experts came to view a shift in the power industry's fuel mix as a priority program. Attainment of this goal is a matter of great importance to the economy as a whole because the power industry is the single-largest fuel consumer in the USSR.[1] [redacted] 25X1

This paper reviews power industry fuel use since 1960. It points out trends and pertinent Soviet policies; examines the most important advantages and constraints in Soviet power plant design, operation, and new construction in relation to the fuel used; and assesses the fuel conversion program, which the Soviets hope will have the greatest effect on fuel use. In addition, we estimate likely ranges of fuel consumption in the electric power sector by type and quantity for 1985 and 1990. Finally, we provide some analysis of how the restructuring of the power industry's fuel supplies could affect the Soviet oil and gas industries, as well as the reliability and costs of electricity production.[2] [redacted] 25X1

[1] Throughout this paper, the term "fuel" refers to organic fuels, including not only the fossil fuels (oil, natural gas, associated gas, coal, and shale) but also refinery byproduct gas, peat, and fuel wood; nuclear fuels are excluded. Similarly, the term "thermal power plant" refers only to conventional (nonnuclear) power plants. [redacted] 25X1

[2] The Soviets publish comprehensive data on the power industry at five-year intervals corresponding to their planning cycles; therefore, the most complete and current data are for 1980. These data have been revised and updated through December 1984 [redacted] 25X1 [redacted] They are summarized in appendix tables covering thermal power plant capacity and fuel-use capability in 1980, projected new thermal power plant capacity and fuel-use capability during 1981-85 and 1986-90, and in a list of power plants in the 1981-85 fuel conversion program. The appendix also explains the methodology used to project total power industry fuel demand in 1985 and 1990 and the industry's demand for major individual fuels (oil, gas, and coal). [redacted] 25X1

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Soviet Plans and Prospects for Reducing Oil Use in the Electric Power Industry

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The Power Industry's Claim on Soviet Fuel Output

The power industry is the largest single consumer of fuels in the Soviet Union. From 75 to 80 percent of all electricity and 50 percent of centralized heat are supplied by power stations that burn organic fuels. Over the last two decades the power industry has tended to consume a growing share of total fuel output, particularly oil (figure 1).

Unlike electric power generation in most other countries, the Soviet power industry provides a substantial portion of the space- and process-heating needs of its customers. This heat is "cogenerated" at power plants, and nearly 40 percent of the fuel consumed by the power industry is used for this purpose. Soviet energy experts anticipate that fuel requirements for cogenerated heat at power plants will continue to grow until the late 1990s, when they expect that nuclear energy will be used extensively in this role.

In the 1960s, the amount of fuel used by power plants nearly doubled. The growth of fuel demand in the power industry far outpaced the growth of fuel production. At that time, however, the potential for imbalance between power industry fuel requirements and fuel production did not alarm Soviet energy planners. The oil, gas, and coal industries were growing steadily, and power industry experts were promising that nuclear energy would soon replace many power plants that use organic fuels.

In the 1970s, power industry consumption increased to about 27 percent of the country's fuel production. Although the rate of growth in power industry fuel demand slowed, Soviet energy analysts became increasingly concerned about the quantities and types of fuel supplied to the industry. In their view, the share of organic fuel output going to the power industry had to be reduced, but nuclear energy was not developing rapidly enough to make this possible. High-level fears about energy arose, reflecting uncertainty concerning the reliability of supplies (particularly of oil) and the outlook for growing energy demand and slow progress toward conservation. Moreover, a number of Moscow's energy experts noted that the share of oil output going to power plants was soaring. 25X1

Oil use at power plants more than doubled in the 1970s, to become the power industry's largest fuel source by 1980 (see table 1). A number of factors favored oil consumption: it burns more cleanly and efficiently than coal; it is easier to transport and store than either coal or gas; and, during the 1970s, power industry designers introduced a new generation of large-scale plants that took advantage of the combustion properties of fuel oil to produce electricity more efficiently and cheaply. 25X1

Coal consumption at power stations—in terms of standard fuel equivalent (SFE)—increased about 20 percent in the first half of the 1970s but declined somewhat by the end of the decade. The dropoff reflected the declining output of coal and its poorer quality in terms of lower heat content and higher noncombustible content. As a result of these changes, coal declined in relative importance as a power industry fuel source, dropping behind oil. Nevertheless, the power industry is still the largest customer for coal, consuming nearly 40 percent of total output, although it competes for supplies with other important consumers such as ferrous and nonferrous metallurgy. 25X1

In the 1960s, when power plants used about 40 percent of total gas output, gas use in the power industry increased more than threefold. As gas distribution networks added a more diverse range of customers in the 1970s, growth in power plant gas use slowed to about 60 percent. During this period many power stations became seasonal gas customers, running on gas in the spring and summer and switching to oil when the fall and winter heating demand for gas peaked. 25X1

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Figure 1
USSR: Electric Power Industry—Claims on Soviet Fuel Output, 1960-80

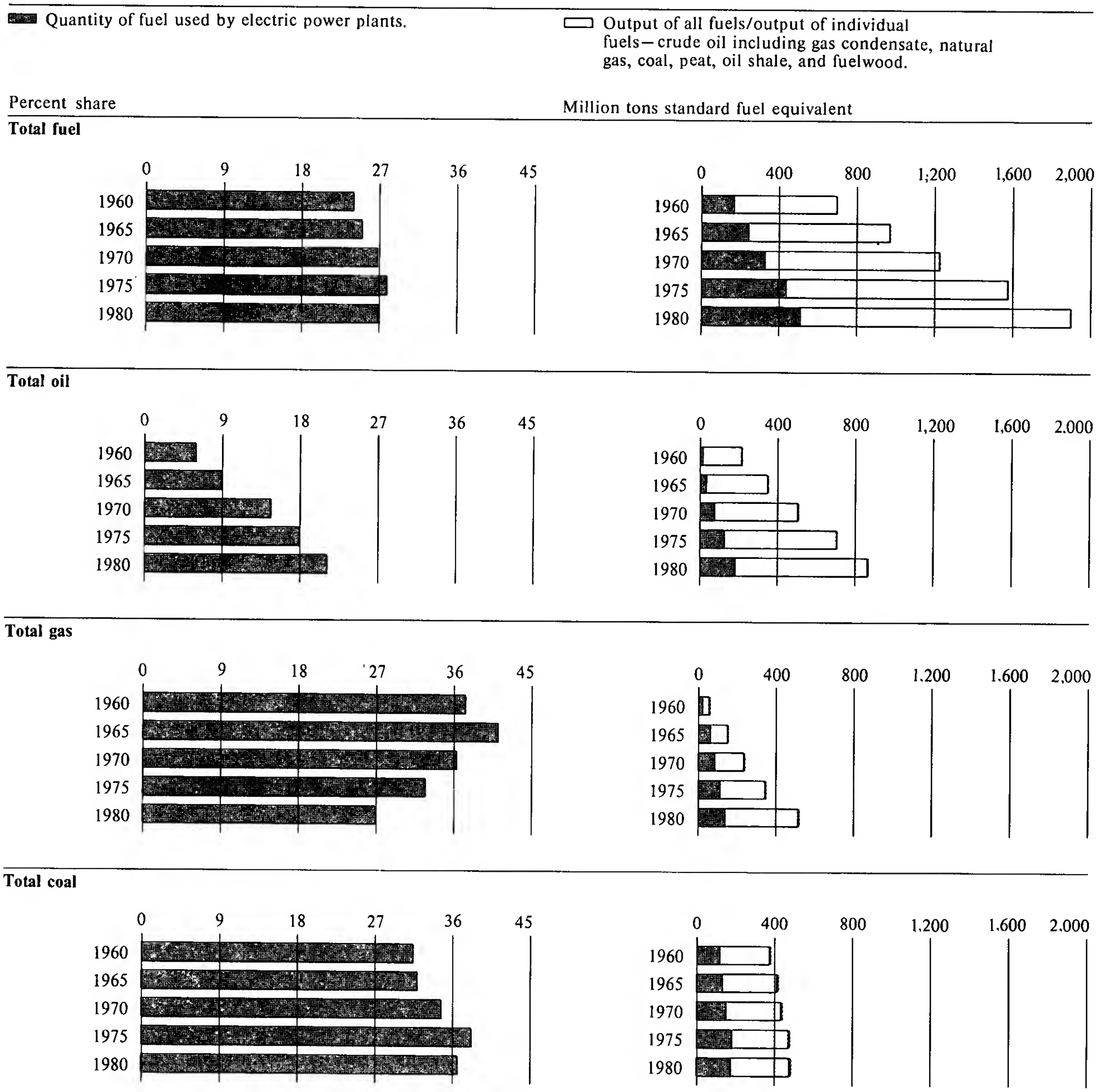

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Table 1
USSR: Measures of Fuel Consumption by All Electric Power Plants [a]

	1970	1975	1980
Oil (*million metric tons*)	53.0	90.8	131.2
Gas (*billion cubic meters*)	71.3	94.3	116.6
Coal (*million metric tons*)	246.0	308.3	313.9
Other (*million metric tons*)	59.0	61.0	48.0
	Million metric tons standard fuel equivalent [b]		
Total	326.1	436.6	509.0
Oil	73.4	125.7	181.7
Gas	84.8	112.2	138.4
Coal	150.3	180.3	174.6
Other	17.6	18.3	14.3
	Million b/d oil equivalent		
Total	4.56	6.10	7.11
Oil	1.03	1.76	2.54
Gas	1.18	1.57	1.93
Coal	2.10	2.52	2.44
Other	0.25	0.25	0.20
	Percent shares of SFE		
Total	100.0	100.0	100.0
Oil	22.5	28.8	35.7
Gas	26.0	25.7	27.2
Coal	46.1	41.3	34.3
Other	5.4	4.2	2.8

[a] Consumption of fuel to produce electricity and cogenerated heat by all power plants, both Ministry of Power and Electrification stations and those plants dedicated to other industries. "Oil" comprises residual fuel oil and diesel oil; "Gas" comprises natural, refinery byproduct, and associated gases; "Coal" comprises hard coal, lignite, and cleaning plant secondary products. "Other" includes shale, shale oil, peat, and possibly some fuelwood or cellulose.
[b] The standard fuel equivalent (SFE) is equal to 7,000 kilocalories per kilogram. The amount of oil, gas, coal, or other fuel products needed to provide this quantity of heat varies among products and may vary over time. According to Power Ministry data:
1 million tons of fuel oil products equal 1.385 million tons SFE;
1 billion cubic meters of gas products equal 1.19 million tons SFE;
1 million tons (averaged) of shale, peat, or fuelwood products equal 0.30 million tons SFE; 1 million tons of coal products equaled 0.61 million tons SFE in 1970, 0.585 million tons SFE in 1975, and 0.557 million tons SFE in 1980.

As Soviet energy policy began to receive greater high-level attention in the early 1970s, the power industry became the focal point for several programs intended to correct what were seen as growing imbalances in energy supply and demand relationships. Notably, the Ministry of Power and Electrification (hereinafter Power Ministry) was directed to increase the use of coal and reduce the use of oil. This goal posed difficult fuel supply adjustments for the power industry because coal use was in decline and oil was becoming the most important fuel source at power plants. 25X1

At least since 1974, when the Soviets were setting fuel targets for the 10th Five-Year Plan (1976-80), increased coal usage has been considered a key route to reductions in power station oil consumption. In fact, during the mid-1970s planners looked to rapid construction of coal-fired generating capacity as the centerpiece of the effort to reduce oil use. 25X1

The 1976-80 plan called for the replacement of oil by coal at new facilities. The plan envisioned the rapid expansion of open pit coal mines and timely construction of mine-mouth power plants as the best means to boost coal consumption and permit reduced oil use. However, the share of coal in fuel consumption at power plants under direct control of the Power Ministry (about 90 percent of Soviet capacity at thermal power stations) declined, while the share of oil rose substantially, as shown in the tabulation (in percent shares of SFE):

	1975 Actual	1980 Actual	1980 Plan
Oil	30	36	28
Gas	22	24	22
Coal	45	37	46
Minor fuels	3	3	4

Thus, by the late 1970s, hopes for coal had faded, overtaken by production problems and the promise of gas-for-oil substitution. 25X1

The coal-centered strategy failed because of constraints in the coal and electric-power industries. Total coal output declined in both the quantity mined

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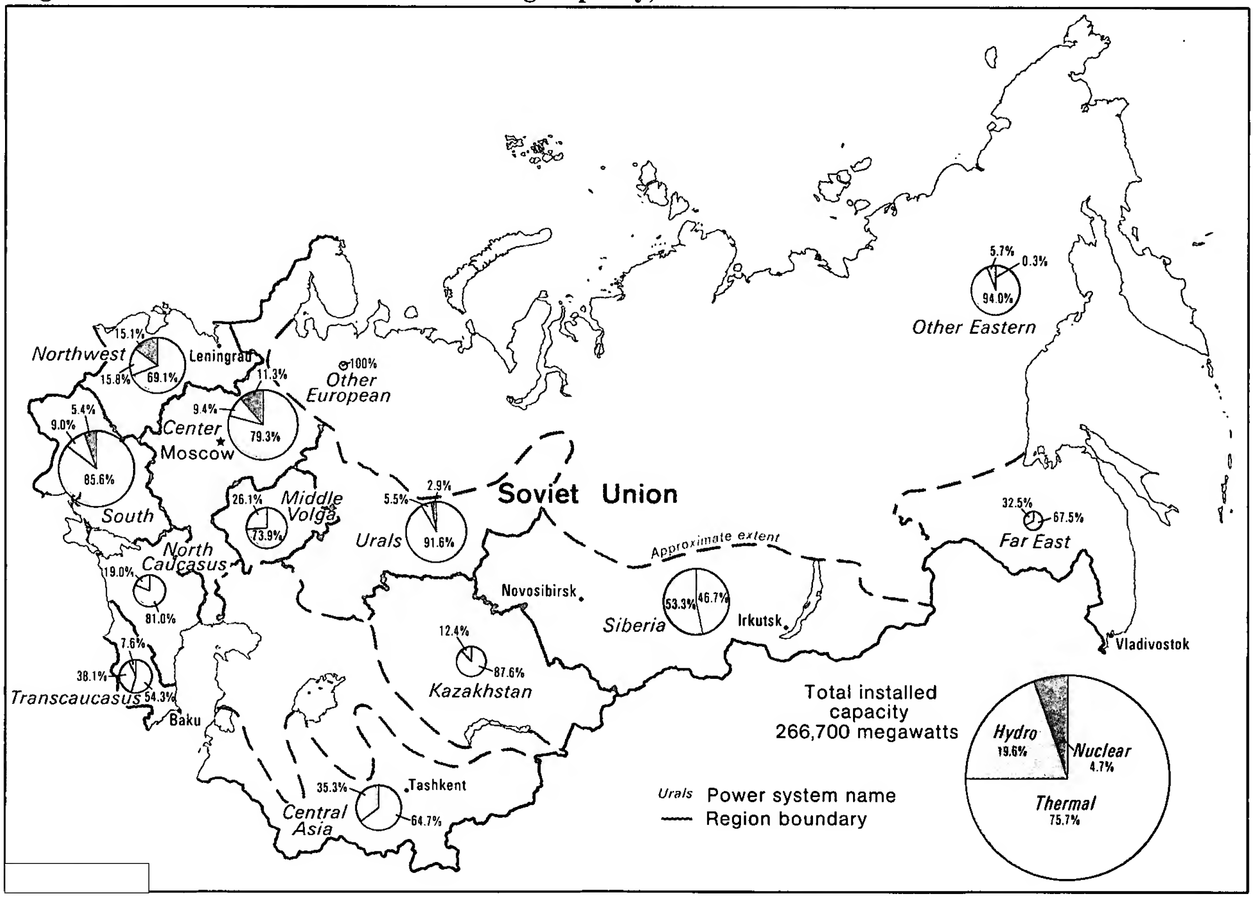
Figure 2
Regional Distribution of Electric Generating Capacity, 1980



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and the heat content of coal delivered to customers, forcing the Power Ministry to offset the resulting shortfalls with increased oil use. Moreover, the industry was unable to complete planned new capacity at power plants located near mines where coal production increased. As a result, greater reliance on coal usage has been postponed as a viable policy until the late 1980s and 1990s, when the Soviets anticipate that mine-mouth power plants east of the Urals will make a major contribution to electricity supply.

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Fuel-Use Capabilities of Soviet Power Plants

Electricity production in the USSR is still very dependent on adequate and timely fuel supply for thermal power plants, despite the substantial use of hydroelectric plants in some regions and a growing contribution from nuclear stations. Figure 2 illustrates the relative shares of thermal, hydro, and nuclear power generating capacity in major regions of the Soviet Union in 1980. The current picture is not much changed. By December 1984, the Soviet electric power system had a total capacity of roughly 305,000 megawatts (MW), with some 223,000 MW (73 percent) at thermal plants, nearly 59,000 MW (19 percent) at hydroelectric stations, and about 23,000 MW (8 percent) at nuclear plants.

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Multifuel Capability of Soviet Power Plants

The Soviets design their thermal power plants to use more than one fuel to ensure against supply interruptions, to circumvent limitations in the fuel distribution

network, and to minimize fuel costs.[4] In 1980, only about 20 percent of Soviet thermal power stations were limited to the combustion of a single fuel. Multifuel capability has important implications for oil consumption and for programs to reduce oil use (see table 2). Almost 85 percent of the thermal power plant capacity in the USSR can use oil, even though only about 10 percent now burns oil as the sole fuel. [redacted]

Coal-Fired Plants

Although more than one-half of Soviet thermal power plants were equipped to burn coal in 1980, coal accounted for only about one-third of the total fuel used by the power industry that year—despite a policy favoring increased use. The main reasons for the coal shortfall were: lagging production, declining quality, bottlenecks and disruptions in transportation, and increased plant downtime because of aging equipment. These factors continue to hinder the expansion of coal's role in power generation, and deliveries to power plants have remained nearly constant since 1980. As a result, the power plants scheduled to use coal must increase their reliance on backup fuels, oil and gas. [redacted]

Soviet plans for construction of coal-fired power stations were ambitious. In 1976-80, about one-third of new organic-fueled capacity—15,000 MW of the planned 43,800 MW—was to burn coal as the primary fuel. By 1980, solid-fueled power plants using coal, peat, and shale were to provide 44 percent of total electricity and 55 percent of electricity from organic fuels. Actually, the solid-fuel share of electricity generation declined. Because of shortfalls in coal production, solid fuels provided only one-third of total power output and two-fifths of the electricity generated from organic fuel. [redacted]

Although industry data for 1981-85 are not yet available, it is clear that the Power Ministry's efforts to increase the use of coal continue to falter—again

[4] The term "fuel-use capability" is used here to describe the original power plant design and later modifications which allow the plant to burn various fuels; these adaptations include boiler configuration, fuel handling and storage facilities, and training of personnel for operation and routine maintenance of the fuel systems. [redacted]

Table 2
USSR: Fuel-Use Capability of Thermal Power Plants in 1980 [a]

Fuel	Megawatts	Percent Share
Maximum capacity (*capable of burning indicated fuel as primary or secondary energy source*) [b]		
Total	176,087	100.0
Oil	148,752	84.5
Coal	90,826	51.6
Gas	66,950	38.0
Minor fuels	6,879	3.9
Actual distribution [c]		
Total	176,087	100.0
Oil	20,256	11.5
Oil/gas [d]	44,643	25.4
Coal/oil	79,407	45.0
Peat/oil	1,189	0.7
Coal/oil/gas	1,542	0.9
Gas/oil/coal	525	0.3
Peat/coal/oil	740	0.4
Peat/gas/oil	450	0.3
Coal/gas	8,419	4.8
Natural gas	8,347	4.7
Byproduct or associated gas	3,024	1.7
Peat	2,769	1.6
Shale	3,045	1.7
Secondary heat	1,731	1.0

[a] This table summarizes the results of our study of fuel consumption at nearly 300 thermal power plants that were operating in the Soviet power system by yearend 1980. The 300 plants represent 176,087 MW of the total thermal capacity of 201,900 MW on line at that time. For a regional summary of the plants studied, see table 9 in the appendix.
[b] All plants that were studied have been aggregated by their capability to burn a specific fuel irrespective of whether this fuel actually was used. The percentage shares thus reflect individual fuels' *maximum potential share* of the total capacity. Because this share calculation ignores the effect of all other fuel usage, multiple counting results.
[c] This distribution summarizes the actual fuel-use capability of the 300 power plants studied.
[d] Primary, secondary, and tertiary capabilities are indicated in sequence, separated by slash marks.

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mainly because of stagnating coal production.[5] Exhaustion of the more accessible reserves has left the older coal basins with much poorer mining conditions—just keeping output from declining is difficult and costly. At the same time, rapid expansion of surface mining has not gone according to plan because investments have been delayed and improvement in the productivity of equipment and labor has been slow.[6]

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Maintaining adequate coal supplies to the power industry has been and will, we estimate, continue to be a major problem, as shown in table 3. In 1980, for example, the reduction in coal shipments from suppliers in the Donets/L'vov-Volynsk (Ukraine), Moscow, and Chelyabinsk/Kizelovsk (Urals) regions offsets nearly 50 percent of the increased availability of coal for power plants from the Kuznetsk, Ekibastuz, and Kansk-Achinsk areas. By 1990, falling output from the Ukraine, Moscow, and Urals regions will probably offset more than one-fourth of the increment in other coal supplies to power stations. Moreover, power plants designed to use the higher quality coals from the older regions generally will not be able to use the lower quality coals from the more recently developed regions without major boiler modifications, downrating of generating capacity, and increased transportation costs (given the longer shipping distances).

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When coal-quality problems interfere with power station operation, a common solution is to switch to a backup fuel (frequently oil). The backup oil can be used to supplement lower quality coal when the coal quality has declined but is still close to the parameters specified in the boiler design. However, when coal quality is much lower than called for in the original plant design, major boiler changes must be implemented before the new, inferior coal can be used.

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Coal Transportation. Delays in the delivery of rail-hauled coal frequently disrupt operations and push down utilization rates at power plants. When coal supplies are delayed by rail bottlenecks—especially after power plant stocks have been exhausted in late winter—the plants often must operate on backup fuel or shut down. Coal haulage will probably become even more troublesome to the power industry later in the 1980s.

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Part of the strain on the rail network results from the need to move increasing amounts of coal from eastern basins to the European USSR to offset coal production shortfalls at western basins. By 1985, for example, the Power Ministry plans to ship 20 million

Table 3
USSR: Sources of Coal Supply for the Power Ministry [a]

Million metric tons of raw coal

	1975	1980	1985 Plan [b]	Projected [c] 1985	1990
Total	**284.7**	**299.3**	**335.2**	**313.5**	**350.0**
Kuznetsk	59.4	74.7	79.7	78.7	83.7
Ekibastuz	44.1	62.4	82.4	80.0	105.0
Donets	64.8	59.7	59.7	54.6	48.6
Karaganda	25.0	25.0	25.0	25.0	25.0
Kansk-Achinsk	19.3	23.3	33.3	33.3	50.0
Moscow	29.0	21.8	21.8	14.0	10.0
Chelyabinsk	12.3	10.1	10.1	7.9	5.9
Pechora	10.0	10.0	10.0	10.0	10.0
L'vov-Volyn'	9.8	7.3	7.3	4.8	2.8
Kizelovsk	2.8	2.1	2.1	1.4	1.0
Other basins	8.2	2.9	3.8	3.8	8.0

[a] Coal supplies for power plants of the Ministry of Power and Electrification. The Power Ministry uses about 90 percent of all coal burned in power plants.
[b] Plan total and most regional detail are from Power Ministry data. Data for Karaganda, Pechora, and Kuznetsk underground mines are CIA interpolations.
[c] Projections are midpoints of CIA estimates based on analysis of the coal mining industry. This analysis assumes that all increases in coal output from the Kuznetsk, Ekibastuz, and Kansk-Achinsk basins go to power plants as planned. We also assumed that coal supply shortfalls resulting from declining output at the Donets, Moscow, Chelyabinsk, L'vov-Volyn', and Kizelovsk basins are apportioned to the power industry in line with past shares of output from each producer.

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[5] The Soviets have not augmented power plant coal supplies by shifting coal from other uses. In the metallurgical industry—the second-largest consumer of coal—the opportunities for reducing coal use are circumscribed by technical considerations, as well as by the potential costs of plant modification and loss of production during the changeover period.

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metric tons of Kuznetsk coal some 3,500 kilometers (km) to power plants in the central industrial region. Not surprisingly, the average length of rail-haul for coal has increased, from 692 km in 1970 to about 830 km in 1983. Coal losses have increased with the length of rail shipments. The longer shipping distances increase the amount of pulverized coal blown out of open cars and the chance that coal of all sizes will be shaken loose from poorly loaded and inadequately maintained railcars. [redacted]

The erosion in coal quality aggravates the coal transportation problem. Ekibastuz coal, which makes up about one-fifth of the raw coal used by power plants, is 40-percent ash (noncombustible matter). Because this coal is not cleaned to reduce the ash content, each year thousands of railcars that would otherwise be unnecessary are required for shipment from Ekibastuz. Another low-quality coal, lignite from Kansk-Achinsk, is subject to spontaneous combustion in transit and often freezes solid in rail cars. These difficulties presently limit its shipment to distances of 600 km or less (see map, figure 3). [redacted]

The low-quality Ekibastuz and Kansk-Achinsk coals are likely to make up a growing share of rail-shipped coal in the 1980s unless programs for "coal-by-wire" transfer of energy are greatly accelerated.[7] Continued design and construction delays at the Kansk-Achinsk mine-mouth power plants will probably force the Soviets to increase rail shipment of this coal—boosting the Kansk-Achinsk share in the tonnage of coal transported by rail from mines from 8 percent in 1980 to about 14 percent by 1990. [redacted]

Backup Fuels. Coal-fired power stations, with few exceptions, use fuel oil; natural gas; or, sometimes, both of these fuels as backup. In 1980, about 88 percent of coal-fueled capacity used fuel oil as a secondary energy source. Nine percent was backed up by natural gas, nearly 2 percent could use either oil or gas, while only 1 percent relied solely on coal. [redacted]

[7] Coal-by-wire energy transfer is a technology for bridging long distances between coal producers and users. In the USSR, power industry coal-by-wire plans for the 1980s call for construction of coal-fired power plants near the Ekibastuz and Kansk-Achinsk mines and transmission of the plants' electricity output to the Urals and the central industrial region over ultra-high-voltage powerlines. [redacted]

To some extent a backup fuel must be used in the operation of a coal-fired power plant. During boiler starts, a higher quality fuel, such as fuel oil or natural gas, is fired initially; then, after the boiler and other systems have reached equilibrium, the plant is shifted gradually to coal. The starting of boilers occurs frequently because of major maintenance, after emergency shutdown, or as part of a routine response to increased electricity demand. About 1 or 2 percent of a coal plant's annual fuel consumption consists of backup fuel used for boiler restart purposes. [redacted]

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The preponderant share of backup fuel, however, is used mainly when electricity (or both electricity and cogenerated heat) is required from a plant that has exhausted its coal stocks. Delivery interruptions range in severity from temporary transportation difficulties to major coal-mining problems. The power industry has built large fuel-oil storage tanks at many coal-fired power plants (and at plants designed for gas or minor fuels) to assure steady fuel supply in these situations (see table 4). The stored oil permits continued operation of the plants at full capacity for periods ranging from a day to about four weeks before oil resupply would be necessary. This capability to switch to standby fuel oil is particularly important in the Ukraine, where, [redacted] more than 5 million tons of fuel oil—96,800 barrels per day oil equivalent (b/doe)—were needed to offset extended coal supply shortfalls in 1980 alone (figure 4). [redacted]

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The backup fuel is also used along with the main fuel when the quality of coal deliveries declines somewhat. Fuel oil or natural gas is then burned simultaneously with the coal to boost the amount of heat released and ensure that steam pressure remains high enough to run the electricity-producing turbine-generators at full capacity. Former first deputy minister of the Power Ministry, E. I. Borisov, acknowledged that nearly 3 million tons of fuel oil (58,000 b/doe) was burned by Ministry power plants in 1982 just to supplement the heat content of low-quality coal. [redacted]

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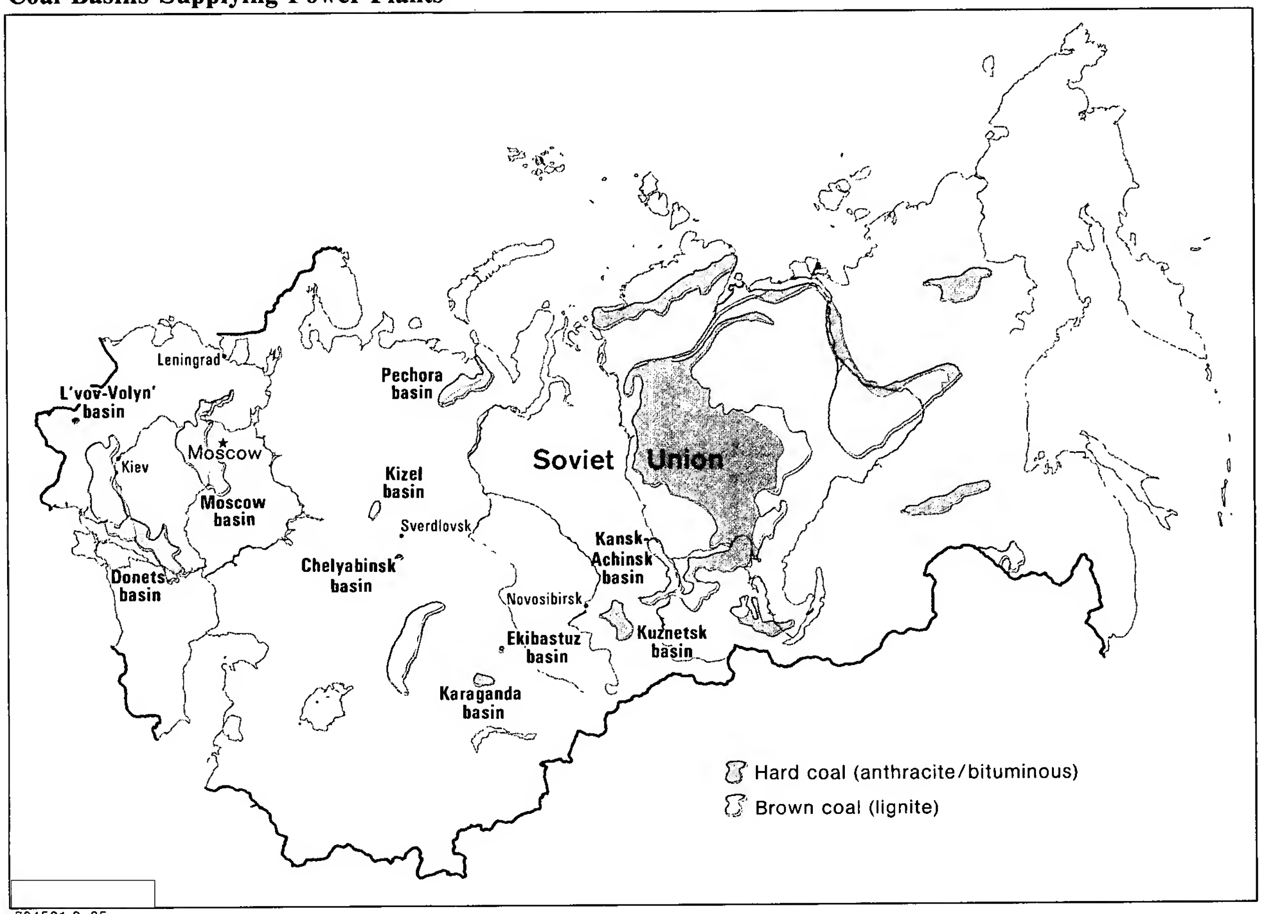
Figure 3
Coal Basins Supplying Power Plants



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Oil-Fired Plants

In the 1970s, the use of oil in power plants grew rapidly. By 1980, oil had overtaken coal as the power industry's leading fuel. The expansion of oil use was facilitated by the ability of nearly 85 percent of thermal power plant capacity to burn oil as primary or backup fuel. The swift increase in oil use was aided by Soviet decisions on oil refining and by policies for improvements to power plant fuel combustion efficiency.

Soviet refineries do not refine crude oil very "deeply." They therefore produce large amounts of residual fuel oil, which is suitable only for burning in big industrial boilers. Power plants are ideal customers for this residual fuel oil—they use large quantities and storage can be accommodated. In 1980, for example, the power industry accounted for about 2.5 million b/doe, or more than 55 percent, of the 4.4 million b/doe of residual fuel oil burned in boilers or furnaces. 25X1

The power industry welcomed the surge in fuel-oil availability that accompanied the expansion of Soviet oil production in the 1970s. Power plants designed for oil use could be built more cheaply and operated with better fuel-use efficiency than plants designed for coal, the chief competing fuel. A shared interest between power industry planners and oil refiners, who were interested primarily in meeting throughput

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Table 4
USSR: Fuel Oil Storage at Selected Power Plants [a]

Plant [b]	Oil Storage (*thousand barrels*)	Primary Fuel [c]	1983 Capacity (*megawatts*)	Equivalent Days of Full Power Output on Fuel Oil [d]
Zaporozh'ye Gres [e]	1,000	Oil/coal	3,600	7.4
		Oil	2,400	
		Coal	1,200	
Syrdar'ya Gres	950	Gas/oil	3,000	8.5
Yermakovskiy Gres	400	Coal	2,400	4.5
Stavropol' Gres	400	Oil/gas	2,100	5.1
Kurakhovka Gres	400	Coal	1,460	7.3
Nazarovo Gres	59	Coal	1,300	1.2
Navoi Gres	122	Gas	1,250	2.6
Gusinoozersk Gres	300	Coal	840	9.6
Cherepovets Gres 2	129	Peat	630	5.5
Arkangel'sk Tets	400	Oil/gas	420	25.5
Takhia-Tash Gres	190	Oil/gas	368	13.8
Tambov Tets	236	Coal/oil/gas	310	20.3

[redacted]

[redacted]

[b] Plants labeled "Gres" (after the Soviet designation for state regional electric power station) generate electricity primarily, if not exclusively. Plants labeled "Tets" (after the Soviet designation for heat-electricity central) provide both electricity and cogenerated heat. Fuel used at Gres and Tets plants is for generation of both electricity and heat.

[c] Fuels at multifuel-capable plants are listed in order of their share during normal operations.

[d] Calculated as the number of 24-hour days-of-operation possible at full plant capacity before fuel-oil tanks are exhausted. It is assumed that tanks are at full capacity to start and that there will be no resupply during period. 25X1 25X1

[e] Capacity of 2,400 megawatts (MW) designed to burn oil and 1,200 MW to burn coal as primary fuel.

[redacted] 25X1

goals, thus helped to promote rapid expansion of oil-fired capacity and related power plant design innovations. These innovations resulted in successive new generations of power-generating units, each larger than its predecessor. By the early 1980s, a sizable number of large, oil-fired units (500 MW, 800 MW, and 1,200 MW) were on line. [redacted]

Soviet energy planners had hoped to make changes in the electric power and refining industries during the early 1980s so that heavy fuel oil displaced by increased use of gas or coal in power plant boilers could be further refined to yield lighter products (diesel fuel, gasoline, and jet fuel). Neither the power industry nor the refining industry has been able to implement the plans that would have led to expanded secondary processing of fuel oil. As a result, refineries continue to produce relatively large quantities of heavy fuel oil—a product that meets power industry fuel needs at plants experiencing coal supply problems or delays in conversion to gas. [redacted] 25X1

Gas-Fired Plants 25X1

For nearly a decade, the power industry has been tasked with bringing its gas consumption more fully into line with the ability of power plants to use gas. In

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1980, for example, 38 percent of thermal power plant capacity could use gas, but gas accounted for only 27 percent of power industry fuel consumption. Limitations on gas use at gas-capable power stations result from an energy policy that gives priority to other customers during seasonal energy demand surges, when the gas pipelines serving an area are unable to meet total demand.

Gas now accounts for about 30 percent of power industry fuel use, indicating that bottlenecks in gas distribution have eased. However, many gas-capable power plants still burn other fuels—primarily oil products—during seasonal upswings in the energy demand of industrial and municipal/residential sectors. The causes of these spurts in gas consumption outside the electric power sector include increased use for residential space heating; industrial process-heating at the end of a quarter when plants are pushed to peak operating rates to meet production quotas; and backup fuel when other gas customers (with backup fuel capability but without adequate backup storage capacity) run low on other fuels.[8]

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[8] The surge in fuel and electricity demand by industrial plants at the end of a quarter particularly strains the gas distribution system. As plants try to win bonuses by meeting or exceeding quarterly output goals, fuel consumption soars; because gas distribution pipelines are not designed to accommodate the peak usage, some customers must be cut back or turned off.

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The amount of gas diverted from power plant use is large. For example, in 1980 the Power Ministry posted an average daily gas consumption of about 284 million cubic meters in December but had used 25 percent less gas in January. On an annual basis, the effect of these limits on gas use is substantial. If gas supplies to the Power Ministry had been maintained all during 1980 at the December rate, total annual gas use by the Ministry could have been increased by about 13 billion cubic meters. The effect of fully utilizing gas at all the power plants connected to the existing gas distribution system is more pronounced when non-Ministry gas-capable power plants are included in the network: we estimate that annual gas use could be boosted by about 17 billion cubic meters.[9]

To bring the power plant gas network close to maximum utilization, the Soviets need to push more gas into the large urban pipeline systems. This task is easiest for plants readily accessible to the major gas trunk pipeline system, which is being greatly expanded during this decade. The relative ease with which the Soviets boosted gas consumption during 1981-83 can be largely explained by this process of bringing some of the existing gas networks to full throughput capacity.

Expanding the capacity of urban gas networks and constructing lateral gas pipelines from the main branch lines to service distant power plants may not be completed until the 1990s. New demands for gas resulting from major new plants or from additions to gas-fired power plants are shown in table 5. In large urban areas, extending the gas network is a slow and complicated task, often requiring tunneling. In a press interview, the deputy chief of a Moscow-area pipeline construction trust stressed that the gaslines must be built without interrupting traffic flow on roads. In the Moscow area, for example, one 38-km pipeline section currently under construction has 70 intersections with roads or with other underground lines.

New Capacity at Thermal Power Plants

Planned construction of power plants using organic fuels is substantial even though the Soviets are counting on rapid growth in nuclear power plant capacity. The original 1981-85 plan called for 35,200 MW of new thermal capacity, constituting 51 percent of total planned power plant additions. About 16,600 MW of thermal capacity went on line during 1981-83, and we estimate a total of 27,500 MW will be completed by yearend 1985 (see tables 10 and 11 in appendix). 25X1

The fuel requirements for the new power plants are substantially different from those originally planned by the Power Ministry. About 70 percent of the 35,200 MW of planned new capacity was to have been fueled by coal, peat, or shale (mainly by coal), but only 45 percent of our yearend 1985 estimate of 27,500 MW has been designed to burn such fuels.[10] The Power Ministry may have made an unpublicized decision to slow down construction of coal-fired power plants, or equipment and construction bottlenecks may have hit coal plants harder than other plants. In any event, the power industry will be hard pressed to obtain sufficient coal for even the reduced number of new coal-fired plants, as well as for additions to plants already operating (see table 6). Without adequate coal supplies for these power stations, the power industry will have to burn more oil or gas than planned at nominally coal-based plants. 25X1 25X1

Despite Soviet claims that very little thermal capacity is being built in the European USSR, we estimate that more than one-third of the total thermal capacity to come on line during 1981-85 is located there. This additional capacity may be advantageous in light of nuclear power plant construction delays. However, the reason the Soviets wanted to curb new thermal power plant construction in this region was the increasing costs of bringing fuels westward from Siberia and Kazakhstan—costs that are probably rising faster than the Power Ministry had anticipated. 25X1 25X1

We project that during 1986-90, about 24,000 MW of new thermal power generating capacity will be brought on line (see tables 12 and 13 in the appendix). This estimate is based on published Soviet targets, 25X1

[9] Increasing annual gas consumption by 17 billion cubic meters at power plants capable of using both oil and gas would save about 284,000 b/doe.

[10] During 1981-85, about 18 percent of the estimated new capacity was designed chiefly for gas firing, and another roughly 36 percent of the new plants can use either gas or oil. Somewhat less than 1 percent of the new capacity will need to use oil as the primary fuel, at least in the short term. 25X1

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Table 5
USSR: Major Additions to Gas-Fired Power Plants and Resulting Fuel Demand [a]

Plant [b]	Capacity (*megawatts*)			Fuel Demand (*million metric tons SFE*)		
	Plan [c] 1981-85	Projected [d]		Plan [c] 1985	Projected [d]	
		1981-85	1986-90		1985	1990
Total	**10,125**	**7,945**	**10,071**	**18.5**	**14.5**	**17.1**
Gas fueled						
Perm' Gres	800		1,600	1.3		2.6
Surgut Gres 1	795	795		1.3	1.3	
Surgut Gres 2	800		1,600	1.3		2.6
Pechora Gres	420	210	420	0.7	0.3	0.7
Moscow Tets 25	250	250	250	0.5	0.5	0.5
Mary Gres	420	210	210	0.7	0.3	0.3
Mangyshlak Gres 3	210	210	210	0.3	0.3	0.3
Navoi Gres	210	210		0.3	0.3	
Nizhnevartovsk Gres			800			1.3
Talimardzhan Gres			800			1.3
Zuyevka Gres 2 [e]		600	600		1.0	1.0
Urengoy Gres			500			0.8
Krasnovodsk Gres			400			0.6
Ivanovo-Voznesensk Gres 2			321			0.5
Gas fueled with oil backup						
Azerbaijan Gres	1,200	900	300	2.0	1.5	0.5
Ryazan' Gres	800	800		1.3	1.3	
Stavropol' Gres	600	600		1.0	1.0	
Kiev Tets 6	500	500	500	1.2	1.2	1.2
Minsk Tets 4	500	250	250	1.2	0.6	0.6
Krasnovodsk Tets 2	420	210	210	1.0	0.5	0.5
Leningrad Tets 26	500	500		1.2	1.2	
Takhia-Tash Gres	420	420		0.7	0.7	
Syrdar'ya Gres	300	300		0.5	0.5	
Tobol'sk Tets	310	310		0.7	0.7	
Moscow Tets 23	250	250		0.5	0.5	
Tallin Tets 2	220	220		0.5	0.5	
Nevinnomyssk Gres	200	200		0.3	0.3	
Moldavian Gres			600			1.0
Sredneural'sk Gres			500			0.8

[a] This table includes additions of 200 megawatts (MW) or larger at new or existing plants.

[b] Plants labeled "Gres" (after the Soviet designation for state regional electric power station) generate electricity primarily, if not exclusively. Plants labeled "Tets" (after the Soviet designation for heat-electricity central) provide both electricity and cogenerated heat. Fuel used at Gres and Tets plants is for generation of both electricity and heat. Plants with oil backup can burn either oil or gas and have sizable oil storage on site; gas demand is calculated for operation only on gas.

[c] [redacted] The 10,125 MW is nearly all the gas-fired capacity in the published original plan. Plan (1985) fuel demand is about maximum annual demand by total new planned additions during 1981-85.

[d] CIA projection of 1981-85 and 1986-90 additions to capacity based on analysis of construction progress and extrapolation of trends to 1990. The 7,945 MW projected for 1981-85 is about half of the estimated new gas-fired capacity to be completed by yearend 1985. The 10,071 MW projected for 1986-90 is 80 percent of the new gas-fired capacity likely to be built in that period. Projected fuel demand in 1985 and 1990 is based on estimates for operation at effective maximum annual capacity utilization rate (63 percent). Actual utilization in 1985 and 1990 could range from 47 to 63 percent, according to past performance.

[e] The Zuyevka Gres 2 was designed as a coal-fired plant but was converted to gas before any boilers began operating.

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[redacted]

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Table 6
USSR: Major Additions to Coal-Fired Power Plants and Resulting Fuel Demand [a]

Plant [b]	Capacity *(megawatts)*			Fuel Demand *(million metric tons SFE)*		
	Plan [c] 1981-85	Projected [d]		Plan [c] 1985	Projected [d]	
		1981-85	1986-90		1985	1990
Total	**10,370**	**5,430**	**8,470**	**20.3**	**10.4**	**15.8**
Ekibastuz Gres 1	2,500	2,500		4.1	4.1	
Ekibastuz Gres 2	1,500	500	3,500	2.5	0.8	5.8
Ekibastuz Gres 3			500			0.8
Berezovka Gres 1	1,600		1,600	3.1		3.1
Gusinoozersk Gres	1,260	420	420	2.5	0.8	0.8
Zuyevka Gres 2 [e]	600			1.2		
Angren Gres 2	600	300	300	1.2	0.6	0.6
Neryungri Gres	600	210	390	1.6	0.4	1.2
Primorsk Gres	600	600		1.2	1.2	
Yu. Kazakhstan Gres			500			0.8
Kharanor Gres	210		420	0.4		0.8
Omsk Tets 5	240	240		0.7	0.7	
Novo-Zima Tets	220	220		0.6	0.6	
Izhevsk Tets 2	220	220		0.6	0.6	
Kurgan Tets	220	220		0.6	0.6	
Krasnoyarsk Tets 3			360			1.0
Krasnoyarsk Gres 2			270			0.5
Smolensk Gres [e]			210			0.4

[a] This table includes additions of 200 megawatts (MW) or larger at new or existing plants.
[b] Plants labeled "Gres" (after the Soviet designation for state regional electric power station) generate electricity primarily, if not exclusively. Plants labeled "Tets" (after the Soviet designation for heat-electricity central) provide both electricity and cogenerated heat. Some Gres plants are hybrids; the Neryungri Gres, for example, is designed to have two 180-MW Tets additions. Fuel used at Gres, Tets, or Gres hybrids is for generation of both electricity and heat.
[c] [redacted] The 10,370-MW total is about 40 percent of the published original plan for new coal-fired capacity. Planned fuel demand for 1985 is nearly equal to the maximum annual demand by total new planned additions during 1981-85.
[d] CIA projections of 1981-85 and 1986-90 additions to capacity at new and existing plants are based on analysis of construction progress and extrapolation of trends to 1990. The 5,430 MW projected for 1981-85 is about 48 percent of the estimated new coal-fired capacity to be completed during these years. The 8,470 MW projected for 1986-90 is nearly 90 percent of the likely coal-fueled new capacity built in that period. Projected fuel demand in 1985 and 1990 is based on capacity estimates operated at effective maximum annual utilization (63 percent). Actual utilization in 1985 and 1990 could range from 47 to 63 percent. 25X1
[e] The Zuyevka Gres 2 was designed as a coal-fired plant but converted to gas before any boilers began operating. The Smolensk Gres was designed as a peat-fired plant, but the Soviets plan to convert it during construction to coal use. 25X1

[redacted] 25X1

Power Ministry plans to reduce thermal plant construction and boost nuclear plant construction, and observed progress on construction of power plants accounting for nearly 21,000 MW of that total. Our projections of the fuel-use capability of this new capacity are preliminary—the Soviets have already announced the redesign of two major power plants

(about 9 percent of the estimated 1986-90 thermal power plant increment) from coal to gas.[11]

Power Plant Fuel Conversion

Since the mid-1970s, the Soviets have considered power plant fuel conversion as one of their most important tools in reducing oil use (see inset).[12] As indicated above, natural gas is now the critical fuel in the USSR's boiler conversion program. Conversion to coal use has been studied but implemented only on a very small scale. There have even been some cases where coal- or peat-fired power plants were converted to oil use when the superior quality and assured supply of fuel oil was judged to result in substantial improvement to plant performance and reliability.

Moscow's 1985 goal is to change the fuel input to about 32,000 MW of power plant capacity—nearly 14 percent of total projected thermal power station capacity. We believe that this goal is overly ambitious and that the Soviets will convert roughly 15,000 MW by yearend 1984. At this pace, they should be able to shift nearly 5 percent of the power industry's 1985 fuel consumption almost entirely to natural gas. Reductions in oil use will be limited to about 240,000 b/doe, because more than three-fifths of the targeted plants burned solid fuels or some gas before the proposed modifications. The current (1981-85) power plant conversion program has become a series of ad hoc adjustments to unexpected changes in fuel supply—mainly coal shortfalls—rather than an integrated plan. Despite these circumstances, substantial progress has been achieved in conversions: nearly 11,000 MW of capacity had been completed by February 1984—35 percent of the apparent 1985 goal (see table 7).

[11] Currently, about 44 percent of the power plant capacity that we expect to be completed during 1986-90 is designed to use solid fuel (41 percent will use coal), less than 1 percent is scheduled to burn primarily oil, 36 percent of the capacity will use only gas, and another 20 percent will be equipped to use either gas or oil.

[12] The Soviets use the term "power plant fuel conversion" to describe a range of activities. In the broadest Soviet usage, "conversion" entails any change at the power plant or in the fuel distribution system (chiefly gas networks) that results in increased consumption of the target fuel. In a narrow sense, "conversion" is often used to describe only those modifications at a power plant necessary to equip the plant to burn a fuel other than the one it has been using. Other modifications to the fuel distribution network are, however, usually necessary before the plant can use the "new" fuel. Distinguishing the type of conversion being referred to in Soviet source material is important because of the likelihood of large differences in types and amounts of fuel consumption associated with the completeness of conversion.

Conversion Efforts of the 1970s

Power plant fuel conversion is not new to the Soviets. Before the mid-1970s, however, fuel "conversion" was simpler to execute: it involved power plant modifications to improve fuel-consumption efficiency at plants using multiple fuels, not, for the most part, substitution of fuels—a process that requires the coordination of several bureaucracies. For example, a former Power Ministry boiler inspector reported on an effort begun in 1970 to improve the efficiency of oil and coal use in coal-fired power plants in the Ukraine. By the time this effort was completed in 1979, about 17,800 MW of capacity had been upgraded—nearly half the thermal power station capacity in the Ukraine. The Power Ministry made these changes with little involvement of other ministries.

Major efforts to reduce oil consumption were attempted as early as 1978, when Gosplan announced a decision to convert combustion equipment at 265 installations from fuel oil to natural gas. A large share of these proposed conversions were at power stations in the Urals and Volga regions, along the route of the main gas pipelines planned from Medvezh'ye and Urengoy. The Soviets assessed the results of this early conversion program in 1980 and were largely disappointed. In the Urals region several major power stations cut back or ceased oil use, but conversion lagged at many others. In the Volga region the conversion program had not shown results—the Power Ministry did not have ready the detailed plans necessary for timely conversion, and the gas pipeline sections and compressor stations were not brought on line according to schedule.

There have been at least three versions of power industry planning for conversions since January 1980. The 1981-85 power plant conversion program previewed in January 1980 by the director of Gosplan's Institute for the Study of Fuel/Energy Problems called for conversion of large oil-fired power plants in the Urals and Volga regions to natural gas. The projected reductions in oil use were about 250,000

Table 7
USSR: Power Plant Fuel Conversion, 1981-85 [a]

	Capacity	
	Planned 1981-85	Completed by 31 January 1984
Total *(megawatts)*	**31,718**	**10,996**
Distribution by primary fuel before conversion [b]		
Oil	10,162	4,287
Oil/gas	8,260	3,910
Coal	11,964	2,287
Peat	1,332	512
Distribution by primary fuel after conversion [b]		
Gas	31,496	10,874
Oil	162	62
Coal	60	60
Projected annual reduction in oil use [c] *(thousand b/doe)*	420-575	175-245

[a] Planned conversions summarize all plants identified by the Soviets as scheduled for conversion to full operation on a new fuel source during 1981-85. Completed conversions are shown as of 31 January 1984. See table 14 in the appendix for list of individual power plants.
[b] Capacity labeled "oil/gas" burned some gas fuel even before conversion.
[c] To calculate the reduction in oil use achieved by plant conversion, the type(s) and quantity of fuel being displaced must be known. Unfortunately, the Soviet practice of multifuel usage gives this calculation a range of likely values. Upper estimates of both ranges show oil savings, if before conversion 25 percent of coal capacity used oil as fuel (in addition to all oil capacity and all oil-gas capacity). Lower estimates of ranges show oil savings, if before conversion all oil and 50 percent of oil-gas capacity used oil.

b/doe. This version of the 11th Five-Year Plan conversion agenda was little more than an effort to finish the work begun in the late 1970s.

When the Power Ministry published the details of its 1981-85 plans in 1981, the conversion program had been doubled in comparison with the 1980 preview. The new goal was to cut oil use by nearly 500,000 b/doe in 1985, with the effort focused on oil-to-gas conversion not only in the Urals and Volga regions but also in the central Moscow region and the Ukraine. Thus, it was expected in the second version of the conversion program that large, new gas supplies would be available to substitute for oil along the route of the Urengoy-Center gas transmission pipelines. The coal supply shortfalls that developed were not anticipated. 25X1

The current version of the conversion plan, announced in December 1983, retains an oil-use reduction goal of about 500,000 b/doe in 1985 but puts top priority on using gas to eliminate backup oil use at coal-fired power stations. The direct substitution of gas for oil at oil-fired plants has been given a reduced priority. The Power Ministry, however, has not publicly acknowledged that the net effect of shifting emphasis from replacement of oil with gas to the current priority of gas-for-coal makes attainment of even the original 250,000-b/doe oil reduction target unlikely. Power industry plans include the construction of 27 major natural gas branch pipelines being built to connect large power stations with the main gaslines from Urengoy. 25X1

Conversion to Natural Gas

The process of switching a power plant from coal or oil to gas use is not technically demanding and need not take the plant out of service for more than several weeks if gas supply is already in place (see inset for possible exceptions). Most Soviet power plants that have used oil as the primary fuel have boilers originally designed to burn gas. Consequently, these plants can be operated at their full rated capacity after conversion to gas and may actually increase their fuel consumption efficiency and reliability. 25X1

25X1

Although simple in theory, the gas conversion process in the USSR enounters complications related to the multiple bureaucracies that must jointly design, produce components for, construct, and operate the gas pipeline system connected to a power plant. In some cases, coordination among the organizations involved—the Gas Ministry, Petroleum and Gas Construction Ministry, Power Ministry, regional construction trusts of the Power Ministry, and individual power plant management—works fairly smoothly. For example, the Syrdar'ya Gres plant (3,000 MW) was fully converted from oil to gas use in somewhat more than one year. 25X1 25X1

Problems in Using Natural Gas in Large Boilers?

The power industry has been very slow in converting the largest oil-fired units to gas use and in bringing on line the largest new units fueled solely by natural gas. These delays are surprising in view of the broad objectives of cutting back oil use and boosting gas consumption. [redacted]

We can only speculate on possible reasons for the problems the Soviets are currently encountering in using their largest boilers. Conversion delays would result if the Power Ministry were reluctant to take an 800-megawatt (MW) unit (a sizable amount of generating capacity) out of service even for the several weeks needed to modify boilers and connect gaslines. Such reluctance is warranted because there is little or no reserve capacity for the generation of electricity in most of the USSR. Another possible explanation of both delayed conversions and delayed startups of large, natural-gas-fired units could be the overspecialization of Soviet boiler designs. It is possible that the largest boilers were designed to maximize oil consumption efficiency and cannot be easily adapted to use alternative fuels. [redacted]

By January 1984, the largest organic-fuel-fired power-generating units in the USSR were one 1,200-MW and 10 800-MW power units that were in operation at four power plants. At most, three of the 800-MW units (located at one plant) had been converted from oil to gas use. The Soviet press announced this conversion was completed in November 1983, [redacted] *Assuming that the three 800-MW units have been converted to gas, the remaining 6,800 MW of large units will use about 150,000 b/doe of oil products each year. Availability of gas should not be an issue in at least some and possibly all of these conversion delays because new gas trunklines have been completed within a few miles of the power plants.* [redacted]

The power industry is also behind schedule in bringing on line two new natural-gas-fired 800-MW units. Delays at one of these units (Perm' Gres) can be largely explained by the preconstruction work made necessary when the plant was redesigned from coal to gas. However, the other 800-MW unit (Surgut Gres 2)—scheduled for completion this year and critically needed by the oil and gas producers in Tyumen' Oblast—is unlikely to supply electricity until 1986. [redacted]

Conversions at many other plants, however, experience long delays, because one or more of the organizations involved in linking the plants with the gas distribution network fails to do a job. At the Karmanovo Gres (1,800 MW), for example, oil-to-gas conversion was scheduled for October 1983, following about a year of preparations. Problems with the supply of material and equipment for construction of gaslines continued to plague the station into early 1984. About one-fifth of the power stations slated for conversion to gas during 1981-85 have had similar serious delays. These delays have increased the time needed to change fuels by one to three years. Another one-fifth of the power plants to be converted by 1985 are experiencing less serious delays ranging up to one year. [redacted]

Compared with previous plans, the current program for conversion to gas is a much more complex effort, and the amount of oil reduction is constrained. As noted earlier, initial Soviet planning (1976-80) for power plant boiler conversions to gas use depended on minor adjustments at power plants in the Urals and Volga regions and the tapping of expected increases in gas supplies. If these conversion plans had succeeded, the Soviets would have been able to increase gas use and at the same time back out sizable quantities of oil at these power plants. Because of coal supply problems, however, the power industry is now stressing

coal-to-gas conversion while still hoping to back out as much oil as originally planned. Although switching from oil to gas as the backup fuel at coal-fired plants can reduce the effects of coal shortfalls on oil consumption, the reduction in oil use will be less than could be achieved if all the gas were substituted in power plants that burn only oil. [redacted]

According to the latest conversion plans, the Power Ministry will attempt to convert 31,718 MW of capacity before yearend 1985. The conversions are intended to increase gas use by about 50 billion cubic meters annually, reduce oil use by 420,000 to 575,000 b/doe, and cut back raw coal use by about 40 million tons. However, at the current pace of conversion, only 15,000 MW of plant capacity will be modified in time to affect fuel consumption in 1985. This amount of conversion would probably boost gas use by 23 billion cubic meters, reduce oil consumption by 220,000 to 250,000 b/doe (with oil savings most likely to fall about 240,000 b/doe), and decrease coal use by 20-24 million tons (raw coal). (The latest schedule of power plant fuel conversions is shown in table 14 in the appendix.)
[redacted]

During 1986-90 the power industry probably will try to accelerate the gas conversion program, but the outlook for attaining more ambitious targets is unclear. On the positive side, the experience gained in the current conversion effort should lead to a reduction in the bureaucratic bottlenecks that have delayed the approval process for conversion of plants; the production and timely shipment of the necessary pipeline segments, compressors, valves, and other equipment; and the assignment of work crews. On the negative side, however, plants targeted for conversion to gas in 1986-90 will be farther from the main gas pipelines and probably technically more difficult to convert than currently selected plants. Consequently, we expect that much, if not all, of the gains from increased efficiency in the planning and execution of conversion will be offset by increased requirements for pipeline construction and complications in modifying boilers at large oil-fired power plants slated for conversion (see inset). [redacted]

During 1986-90, we estimate that the Power Ministry will convert some 15,000 to 20,000 MW of capacity to gas use. Consumption would be boosted by 23-34 billion cubic meters, approximately the annual throughput of one main gas trunkline. The lower end of this range represents the completion of the scheduled conversions that we estimate will remain from the current five-year plan. The upper end contemplates the completion of the current conversion program plus 4,000 MW from plants newly targeted for conversion. If all the additional gas were to displace oil, power plant consumption of oil could be reduced by up to 565,000 b/doe. By 1990, however, the power industry will probably continue to have problems with coal quality and intermittent shortfalls in supply. Gas will be used to work around these difficulties. Perhaps as much as 40 percent of the gas going to converted power plants could be needed to offset the shortfalls, if the experience of 1981-85 is repeated. [redacted] 25X1 25X1

Conversion to Coal

Modifying a power plant to use coal rather than oil or gas is the most difficult of conversions, [redacted] 25X1 Unless 25X1 the power station boilers were originally designed to use coal, major alterations are necessary. These require sizable investment, extended plant downtime (perhaps as long as two years), and often result in reduced electrical generating capacity. For these reasons—and because of the specialized staffing needs at coal-fired plants and the requirements for heavy-engineering construction necessary to convert a plant to coal fuel—the Soviets have indicated that few power plants will be converted to coal use in the near term. [redacted] 25X1 25X1

[redacted] 25X1 availability of 25X1 the relevant skilled labor is very important in the decision to convert to coal, in the speed with which conversion takes place, and in the effective operation of the converted plants. The engineering skills needed to modify boilers, install coal-handling equipment, and rework control instrumentation in conversion to coal are in strong demand elsewhere—in shipbuilding, nuclear power plant construction, and construction of major facilities such as refineries. In the Soviet Union, defense industry and high-priority projects such as nuclear power plant construction probably have first claim on heavy-engineering personnel. 25X1
[redacted] 25X1

An important factor in the decision to convert to coal fuel and in the reliability of a recently converted plant is the availability of personnel experienced in coal-based power station operations. Unless a power producer already employs or has recruited people who know coal systems, the utility is likely to have serious problems with plant malfunctions and downtime.

During 1981-85 we believe that at least one 60-MW power plant, the Blagoveshchensk Tets in the Bashkir ASSR, is a candidate for conversion from oil to coal. Although articles in Soviet power industry journals reflect a willingness to push conversion to coal despite the technical obstacles, present coal-supply problems make a major attempt before the late 1980s unlikely.

Power industry officials have also discussed plans to convert power plants from one type of coal to another—usually to one of lower quality. This coal-to-coal conversion aims at reducing the use of backup fuels and finding users for new supplies of poorer quality coal. It is a policy option at power plants where the original coal supply has not been maintained and new coal supplies of lower heat content are being supplemented, in part or wholly, by fuel-oil injection into the boilers. Nevertheless, this sort of conversion requires major new equipment or extensive upgrading of existing coal-handling machinery and boilers. Because of the consequent disruption of power plant operations, only a few plants have been selected for coal-to-coal conversion by 1985.

Power plant conversion to coal could become more important in the late 1980s and the 1990s if the coal-supply problems ease and if the Soviets can exploit new fuel technologies. Fuel innovations such as coal-oil mixtures, coal-water mixtures, and fluidized-bed combustion make it easier to use coal in large boilers.[13] The coal-water fuel technology has the added advantage of being adaptable to slurry pipeline transport—a technology that the Soviets hope to exploit on a large scale. 25X1

Rapid implementation of coal-slurry transportation will, however, require Western technology and equipment. Moscow's own development of coal-slurry technology has been stalled in the design and preliminary testing phases for about six years. The Soviets are currently involved with Western firms in engineering-feasibility studies on a proposed 256-km slurry pipeline for central Siberia. These technical discussions with companies from West Germany, Italy, Japan—and indirectly the United States—will probably soon evolve into contract negotiations because the Soviets have declared that they want to operate the 256-km slurry line during 1986-90. At stake immediately are equipment sales of several million dollars. More important, however, the slurry contract winners would have the inside track on even more lucrative contracts for Soviet transcontinental slurry lines of the future. 25X1 25X1 25X1 25X1

Conversion to Oil

Despite the emphasis in the power plant conversion program on reducing oil use, some power plants are being converted from peat to oil during 1981-85. The amount of capacity currently scheduled for this kind of conversion is small (162 MW), but these plants may be just the entering wedge of a program to reduce sharply or end the use of peat in power plant boilers. By 1990, there would be about 5,000 MW of peat-fired capacity available for conversion. Converting all or most of the peat-fueled capacity to oil use (an unlikely outcome) would increase oil consumption by about 135,000 b/doe. 25X1 25X1

Peat-fired power plants are concentrated in two areas near the peat bogs of Leningrad and Moscow. Power Ministry discussions of these plants have noted the fluctuation in peat fuel supplies to power stations in recent years. This situation probably was a factor in Power Ministry endorsement of Gosplan's longer range goals to curtail reliance on peat as a fuel and increase peat shipments to agricultural consumers. The initial conversions took advantage of available oil

[13] Fluidized-bed coal combustion is a technology under development that promises increased fuel consumption efficiency, flexibility to burn coals of varying quality, reduced emissions of sulfur and nitrogen oxides, a solid waste that is easier to dispose, and potentially lower plant investment. The principle of this technology involves the feeding of crushed coal for combustion into a bed of inert ash mixed with limestone. The mixture is fluidized (held in suspension) by injection of air through the bottom of the bed at a controlled rate great enough to cause the bed to be agitated much like a boiling fluid. The noncombustible materials in the bed remove sulfur emissions and trap ash. 25X1

backup combustion and storage facilities to improve power plant performance and reliability in the shortest possible time. In the medium-to-long term, however, the power industry is more likely to substitute gas for peat, even though this conversion effort would somewhat diminish resources dedicated to reduction of oil consumption by other power plants. [redacted]

Conversion Costs

The investment needed to convert power plants to gas use is the only major direct cost to the economy of restructuring the fuel balance in the power industry. Conversions to oil or coal are only a small fraction of the total conversion program. We estimate that the projected 1981-85 conversion-related investment for 15,000 MW of power plant capacity fuel changes will be roughly 500 million rubles. Branch pipeline construction accounts for the bulk of this spending. Total *annual* investment in the power industry is currently at 4.5 billion rubles, so conversion costs do not seem prohibitive. [redacted]

Conversion from oil to gas, moreover, has been cited in the Soviet power industry literature as a way of reducing power plant operating costs. At one 3,000-MW plant converted to gas use, the deputy minister of power in the Uzbek republic expected that the annual fuel bill would be reduced by roughly 40 million rubles because gas is cheaper for the Soviets to produce and ship than an equivalent amount of fuel oil. If this experience were repeated at all the power plants that we estimate will be able to switch from oil to gas use, the annual cost of fuel purchases could be cut by 220-230 million rubles by the end of 1985. Savings of this magnitude imply that oil-to-gas conversion might pay for itself in less than three years. [redacted]

Projections of Power Industry Fuel Use

Total fuel demand in the power industry depends on cogenerated heat and electricity needs in the USSR and the power industry's ability to meet these demands. Several indicators of the likely range of these requirements for 1985 and 1990 are available from corresponding five-year plan targets.[14] For example, cogenerated heat production in 1970 and 1975 diverged from the respective plans by 10 percent and for 1965 and 1980, by less than 2 percent. Drawing on plans for 1985 and extrapolating annual growth rates to 1990, we project that power plants will cogenerate 1,335 million gigacalories of heat in 1985 and 1,510 million gigacalories in 1990. Fuel requirements to meet these projected heat outputs will be about 230 million tons standard fuel equivalent in 1985 and 259 million tons SFE in 1990. [redacted] 25X1

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Soviet projections of electricity supply and demand are, unfortunately, not as reliable as the estimates of cogenerated heat. Since the early 1970s, however, the supply side of Soviet power generation has been the main factor in total electricity output. Reporting from Soviet news articles and technical journals, [redacted] all confirm that the electricity output is constrained by such supply factors as plant capacity and availability of fuels. Power shortages, restrictions on electricity consumption, and disruptions related to power shortages at many industrial facilities indicate that the quantity of electricity required to satisfy all uses exceeds the present ability of the Soviet power industry to supply it. We expect that constraints on electricity supply will continue at least through 1990, even with additions to capacity at new or existing power plants. [redacted]

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Thus, by focusing on the key variables of power plant capacity and capacity utilization rates in electricity production, we can predict electric plant output with a reasonable degree of assurance and thereby estimate electricity consumption in the Soviet economy. We have not ignored, however, the possibility that a level of electricity demand much different from the present one could shift power plant fuel usage in coming years. In projecting the kinds and amounts of fuels the power industry could use in 1985 and 1990, we estimated fuel consumption over a range of likely power plant capacity utilization rates that would correspond to varying levels of electricity demand. [redacted]

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We estimate that the Soviet power industry will produce 1,167-1,190 billion kilowatt-hours (kWh) at thermal power plants in 1985 and 1,254-1,294 billion kWh in 1990. Most of the variation in these ranges can be attributed to uncertainty about the amount of electricity that new capacity will be able to produce. [redacted]

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[14] For a detailed description of the methodology used to project power industry fuel demand, see the appendix. [redacted]

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The quantity of fuel needed to yield the estimated electricity output will depend largely on the fuel efficiency of power plants. International comparisons show that Soviet power plants, on average, use fuel somewhat more economically than those in other countries. The economy in fuel use results from factors such as the more extensive use of waste boiler heat for urban centralized heat supply in the USSR and less rigorous pollution control at Soviet plants. Even so, the power industry can be expected to have some success in making more efficient use of fuels. The gains in efficiency, however, will not be as large or as easily achieved as in the 1970s. Poorer quality coal, the growing number of inefficient aging plants, and reduced construction of thermal power stations all will slow progress toward further improvement in fuel efficiency.

In 1980 Soviet thermal power plants required, on average, 328,000 tons SFE per billion kWh of output. We estimate that in 1985 the fossil-fueled power plants will need 326,000 tons SFE to produce 1 billion kWh, and, in 1990, 323,000 tons SFE. Thus, to produce the projected 1,167-1,190 billion kWh in 1985, 346-353 million tons SFE will be needed. Estimated 1990 output of 1,254-1,294 billion kWh will require the use of 369-380 million tons SFE. Under this set of assumptions, the combined fossil-fuel requirement for electric power and cogenerated heat will probably amount to 576-583 million tons SFE (8.05-8.15 million b/doe) in 1985 and 628-639 million tons SFE (8.78-8.93 million b/doe) in 1990.

The distribution of these requirements among the several organic fuels is derived from our analysis of *two principal constraints:* the fuel-use capability of power stations and the fuel supply to those stations.[15] Our analysis shows that the projected fuel-use capability of Soviet power plants in 1985 and 1990 would not be a constraint to greatly expanded use of oil or coal and only a limited constraint to increased use of gas. On the other hand, there are major constraints affecting the supply of oil, gas, and coal. 25X1

Supply of Coal

The outlook for coal supply is probably the most important variable in the fuel-use equation. The coal supply issue has direct relevance because of the large amount of coal-fired capacity already on line and under construction and because—despite the country's vast reserves of coal—future coal deliveries are very uncertain in terms of both quantity and quality. Indirectly, as noted above, coal availability is an important determinant of power industry use of oil. 25X1

The power industry began the 1981-85 plan period with power plants capable of burning more coal than was available. More than 52 percent of yearend 1980 power plant capacity was equipped for coal combustion, but only 34 percent actually operated on coal. In 1985, despite slowdowns in the construction of coal-fired power plants, the conversion of about 3,000 MW of coal-based capacity to gas, and some increase in the coal supply, coal availability probably will still be inadequate to fuel all the coal-capable power plants. 25X1

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We estimate that about 325 million tons of coal will be shipped to power plants in 1985. The operation of all coal-based power plant capacity in 1985 at about 62-percent utilization (which would represent good, somewhat-above-average Soviet performance) would require approximately 350 million tons of coal. This fuel shortfall of 25 million tons would represent an annual loss of up to 40 billion kWh of electricity—a situation that the already taut Soviet power system could not tolerate. If all the projected coal shortfall were offset by oil use, oil consumption would be increased by about 185,000 b/doe in 1985. Instead, the Power Ministry probably would selectively permit power outages and substitute fuel oil for coal when power cutoffs entailed too high an economic cost. 25X1

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[15] To analyze the fuel-use capability of power plants, we studied about 300 power plants that were operating at yearend 1980. These plants represented about 92 percent of steam-driven thermal capacity and 87 percent of all organic-fuel power plants (the latter figure includes small, non-steam-turbine portable power plants). This survey, updated by including projected additions for 1981-85 and 1986-90, shows that plant design for fuel use had—and will continue to have—much built-in flexibility. Through this decade, more than half of Soviet power plant capacity will have the technical capability to burn coal; nearly 40 percent, gas; and about 85 percent, oil.

By 1990, total coal-fired power plant capacity will increase further unless the Power Ministry steps up coal-to-gas conversion. Coal-based plants now under construction will add 10,300 MW of generating capacity during 1986-90, calling for new coal supplies of about 33 million tons per year. Since we project that coal supplies to the power industry could be increased 28-67 million tons by 1990 (output at the upper end of the range is less likely), we believe that the coal deficit could be reduced somewhat by 1990.

Progress in raising supplies of raw coal to the level needed to fuel all the Power Ministry's coal-based plants will not, however, eliminate the growth in oil use required to offset deterioration in coal quality. We anticipate that the average energy value of coal supplies to power plants will continue to fall—a 1-percent annual decline has been the long-term trend. Power plant operators will continue to inject oil into the combustion chambers of coal-fired boilers to maintain steam pressure when coal feedstocks are below the heat value specified in power plant design.

Supply of Gas

The power industry will receive a large increase in gas supply during the 1980s. We project that the growth of gas use, however, will be less rapid during 1986-90 (averaging 5 percent annually) than during 1981-85 (averaging nearly 9 percent). By 1985, under our assumptions, power industry gas consumption will reach 173-186 billion cubic meters annually, about 28 percent of the projected total Soviet natural gas output. Power industry gas use will probably decelerate in the latter 1980s, because:

- The industry will have fully employed all the reserve capacity of existing gas networks.
- Construction of new lateral distribution pipelines will be more costly and difficult.
- Building new gas-fired power plants will have slowed. We estimate that gas use in power plants in 1990 will be 214-240 billion cubic meters.

The utilization of gas in the power industry can be considered in four categories: (1) gas production and transmission at past rates of use, (2) increased delivery to power plants through the existing gas network, (3) gas sent to newly commissioned power plants, and (4) gas delivered to plants converted from other fuel usage. We estimate that by 1985 new gas supplies of about 60 billion cubic meters will be shared among three groups of power plants—40 percent of the increment will flow to plants converted to gas use; 35 percent to new plants recently started up; and 25 percent to plants that, although previously linked to the gas distribution network, will operate more often on gas. 25X1

The rise in the volume of gas supplied to the power industry that we project during 1981-85 exceeds the original goal set by Gosplan. Our projections for 1985 show gas supplies growing by 56-70 billion cubic meters over 1980, compared with the increase of 47 billion cubic meters originally planned. The power industry is overtaking the original goal because of its success in (a) raising the utilization rate of existing gas distribution networks and (b) implementing a crash program to convert more power stations to gas. These successes should more than offset the failure to achieve goals for new construction of gas-fired plants. 25X1

The success with gas supply increases during the current five-year plan could lead to policy mistakes in the future, however. Moscow's energy experts may overlook the special circumstances that made the rapid shift to gas possible in the power industry during 1981-85 and expect equally rapid growth in 1986-90. As noted above, one-quarter of the increment to gas supplies in the current five-year plan will be provided by bringing the existing gas networks to full throughput capacity. By the late 1980s, all or most of the previously constructed power industry gas distribution system will be operating at full throughput. Pipeline builders will certainly be working hard during 1986-90 to extend the gas networks. However rapidly this construction proceeds, it still will take longer to accomplish than pushing more gas into existing pipelines. Moreover, during this period, longer branch lines from the main trunk pipelines to power plants will have to be laid because the plants closest to the main gaslines will already have been connected. 25X1

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We estimate that in 1990 about 50 billion cubic meters more gas will flow to the power industry than in 1985. The increase during 1986-90 could range from 36 to 62 billion cubic meters. This additional gas will be distributed to power plants converted to gas use (61 percent), new power stations (35 percent), and power plants that—although previously connected to the gas distribution system—will operate more frequently on gas (4 percent).

In estimating the gas increase for 1986-90, we have assumed that the industry could at most convert 20,000 MW of power plant capacity to gas use. However, the power industry may only be able to match the amount of conversion (15,000 MW) likely in 1981-85 because of limitations on investment and labor and the greater technical difficulty of projects. Our estimate also forecasts a slight decline in the amount of new gas-capable power plants brought on line during 1986-90 as the Soviets implement plans to rely more on nuclear-generated power. New gas-fired additions will total about 13,200 MW, compared with 14,700 MW scheduled to come on stream before 1986.

Supply of Minor Fuels

Although shale, peat, and fuelwood/cellulose play only a minor role in fueling power plants (about 3 percent), they still cannot be overlooked. According to Power Ministry statements, supplies of these fuels in 1985 and 1990 should be only slightly greater than in 1980, at best. We estimate that minor fuels could contribute up to the planned 15.8 million tons SFE in 1985 but are unlikely to exceed that amount by 1990, because few power plants are being built to burn these fuels.

Supply of Oil

Moscow's hopes for a sharp reduction in oil consumption in the electric power industry will be frustrated at least through 1985 and possibly until the early 1990s. In 1980 the power industry used 2.54 million b/doe of oil products. By 1985, power industry oil consumption (depending on the assumptions made) will probably be 2.29 to 2.69 million b/doe. In 1990 oil use by the power industry of 1.8 to 2.7 million b/doe is likely. Our best estimate is shown in table 8.

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A reduction in oil use by 1985 is unlikely, in our view, because of the essential preconditions: total fuel demand in the power industry would have to be curtailed sharply, coal supplies would have to be increased, and efforts to maximize gas use would have to be almost totally successful (see inset on page 24). During 1981-83, power industry demand for fuel grew at an average annual rate of 2.5 percent. A cut in oil use would be feasible (assuming success on other fronts) if the rise in total fuel use in 1981-85 could be held at or below 2.4 percent per year. However, the Power Ministry has not demonstrated the ability to increase output of nuclear and hydro power sources rapidly enough to make this likely.

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The outlook for increased coal supplies, as discussed earlier, is poor. To reduce 1985 demand for backup oil at coal-fired plants, raw coal deliveries would have to be at least 330 million tons (174.8 million tons SFE). During 1981-83, however, coal supply to power plants remained at the 1980 level of about 314 million tons.

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Finally, to maximize reductions in the use of oil, gas supplies to the power industry in 1985 would have to be about 186 billion cubic meters, compared with 117 billion cubic meters in 1980. To implement this 60-percent increase, the Power Ministry would have to convert 18,000 MW of capacity to gas use (11,000 MW was converted in 1981-83), all new dual-fueled plants capable of operation on either oil or gas would have to operate entirely on gas, and the gas network connected to power plants would have to operate at maximum throughput. If the power industry could accomplish all of this, oil consumption in 1985 could be cut back to 2.29 million b/doe, a reduction of about 250,000 b/doe.

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However, an increase in oil consumption of 150,000 b/doe by 1985 is also possible. The power industry would probably continue to increase its consumption of oil if total fuel demand grew to 583 million tons

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Table 8
USSR: Projected Power Industry Fuel Use [a]

Million metric tons standard fuel equivalent

	1985	1990
Total	**580**	**634**
Gas [b]	211	270
Existing consumers	138	213
Conversions to gas	30	35
New plants	25	20
Gas network gains	18	2
Coal	173	187
Minor fuels	15	15
Oil	181	162
Oil *(million b/doe)*	2.53	2.26
Change in oil use, compared with 1980 consumption of 182 million tons SFE (2.54 million b/doe)	No significant change	Reduced by 275,000 b/doe

[a] Estimates for the use of total fuels, gas, coal, and minor fuels are midpoints of ranges cited in text with the exception of the 1985 gas conversion projection, which was calculated from data on observed conversions.
[b] Total gas use was derived from data on four key components: existing consumers, that is, total gas use in the power industry at the end of the previous five-year plan period; new gas used at plants converted to gas from other fuels; new gas burned by plants that came on line or were expanded during the preceding five years; and additional gas use made possible by changes to the existing gas pipeline system allowing greater gas throughput.

SFE (the amount implied by the generation of 1,190 billion kWh)—somewhat faster growth (2.8 percent per year) than in 1981-83 (2.5 percent per year)—and if:

- The supply of raw coal to power plants remains at the 1980 level, and the energy value of coal continues to decline at past rates.
- Substitution in favor of gas is limited by slower-than-expected conversions (14,000 MW instead of 15,000 MW).
- Constraints in gas-network expansion allow only 85 percent of the new gas-capable power plants to consume gas and also limit gas throughput to 75 percent of the capacity of service pipelines (13 billion cubic meters instead of 17 billion cubic meters).

The increased demand for fuel, coupled with the problems in coal and gas supply, could drive 1985 power industry oil demand to 2.69 million b/doe, about 150,000 b/doe more than 1980 consumption.

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Goals for cutting power plant oil use by about 1 million b/doe by 1990 were announced in the 20-year energy program. We do not expect that the Soviets will be able to restructure the fuel balance in the power industry so rapidly. Oil consumption in the power industry in 1990 will probably range from 1.8 to 2.7 million b/doe. The lower end of this range translates into a reduction in oil use of up to 720,000 b/doe; the upper end, an increase of 170,000 b/doe.[16]

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In our best estimate of fuel consumption in 1990, oil use would fall by about 275,000 b/doe, bringing total consumption in the power industry down to 2.3 million b/doe. This reduction, although not easy, would be feasible if: (a) gas supplies to power plants increase by about 110 billion cubic meters, (b) coal supplies rise by 25 million tons, and (c) nuclear and hydro power programs permit organic-fuel demand in the power industry to slow from the current rate of 2.5 percent per year to 2.2 percent. 25X1

Under circumstances only slightly different from those assumed above, however, power plant consumption of oil could increase by 170,000 b/doe in 1990 compared with 1980 consumption. This consumption rate would occur if (a) coal deliveries to the power industry failed to increase in 1981-90, (b) gas supplies were stepped up by only 97 billion cubic meters, (c) and total fuel demand grew at an average annual rate of 2.3 percent. Oil consumption in the power industry in 1990 could then be as high as 2.7 million b/doe. This situation might develop if, for example, energy investment during 1986-90 were directed to maintaining oil production while funding for coal, gas, and nuclear programs was constrained. 25X1 25X1

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Factors Working Against Reduced Use of Oil in Power Plants in 1985

During 1981-85, three major developments (one planned and two unplanned) are impeding the power industry's effort to reduce oil consumption. These developments—increased demand for fuel at newly commissioned coal-fired power plants, below-plan deliveries of coal, and larger-than-planned fuel demand for the power industry as a whole—will probably combine to increase demand for fuel oil. If unconstrained, these changes would increase oil use by up to 800,000 b/doe. We do not believe that the Soviets would allow this to happen; instead, we expect the Power Ministry to offset much, but not all, of the unplanned increase in oil demand by emphasizing gas use.

The Power Ministry will add about 12,000 MW of new coal-fired capacity during 1981-85. There will be a net increase of about 7,000 MW to the inventory of coal-fired plants, because 3,000 MW of coal-fired capacity will probably be converted to gas use and 2,000 MW of older coal-based plants are likely to be retired. Still, total coal-based capacity will increase faster than the projected increase in coal supplies, necessitating greater use of backup oil.

Below-plan deliveries of coal will add to the fuel-mix problems that the power industry will experience in 1985. The Power Ministry planned for 1985 coal deliveries of 335 million tons (raw coal) but is likely to receive only 314 million tons because of production problems. We estimate that all coal-fired plants (the Power Ministry's stations and those belonging to specific industries) planned on about 350 million tons of coal but will receive only 325 million tons. Most, if not all, of the shortfalls will be offset by using backup oil. 25X1

More fuel, probably both gas and oil, will be needed to generate above-plan electricity at thermal power plants because of below-plan output at hydroelectric and nuclear power stations. In 1985, the power industry was scheduled to provide 1,105 billion kWh from thermal power plants. We project 1985 output from these plants at 1,167-1,190 billion kWh, compared with 1,127 billion kWh in 1983. To provide about 7 percent more thermal power than originally planned, the power industry will need an additional 22 million tons standard fuel equivalent. This translates into a demand for an additional 300,000 b/doe in oil products or 18 billion cubic meters more gas—or some combination of these fuels.

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At most, according to our projections, the power industry could manage to reduce oil consumption by 720,000 b/doe during 1981-90. To accomplish savings of this magnitude, the Power Ministry would need 40-45 million tons more raw coal and about 123 billion cubic meters of new gas. In addition, the growth of fuel demand would have to fall to an average annual rate of 2.1 percent, mainly through the generation of a much larger share of electricity at nuclear and hydro plants. We doubt that the Soviets will be able to find the resources to satisfy all of these requirements.

Implications

Because the power industry is the largest consumer of fuel in the USSR, changes in its fuel mix have major implications for the oil, gas, and coal industries and for power industry customers who face disruptions in power supplies during fuel changeovers. The oil industry will probably have to supply fuel oil to the power

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industry at close to the current level until the late 1980s. The continuing demand for residual fuel oil by power plants may be one reason why the expansion of secondary oil processing facilities (needed to "crack" residual fuel oil to produce larger quantities of gasoline and diesel oil from a barrel of crude oil) is not being pressed more vigorously. Although prospects are good for major substitution of gas for other fuels, the rate of substitution will probably slow by the end of the decade. This may well curb the growth of total gas output. Fuel supply problems at power stations will probably further strain power networks, leading to a greater incidence of power outages, brownouts, and the like.

The Oil Industry

Above-plan consumption of residual oil will tend to postpone the need for a large and rapid expansion of secondary oil refining capacity.[17] The perception of the power industry's progress in cutting oil use is likely to be a key determinant of the direction and pace of oil refining development. The oil industry must satisfy growing demand for diesel oils and gasolines. Central planners hoped that these necessary light products could be obtained by cutting back power plant fuel oil use and putting the "saved" fuel oil through newly built secondary processing units. However, judging by the small number of these units under construction, planners may be holding back on the large investments needed to rapidly expand secondary processing until progress in reducing power industry oil demand is evident.

The Soviets had been counting on cuts in power plant consumption of oil to free 500,000 b/doe of residual fuel oil for further refining into gasoline and diesel fuels in 1985. At most, only about 50 percent of the anticipated amount will be available for secondary refining. In 1990, the best-estimate reduction in power plant oil use of 275,000 b/doe would increase the feedstock available for secondary refining, but by a level far short of what the Soviets hope to achieve—1 million b/doe. Our lower estimate is, however, far more consistent with the observed pace of construction on Soviet cracking capacity to further process the fuel oil.

If the Soviets had hoped to export the oil "saved" at power plants either directly as fuel oil or as more refined products, then they will be forgoing sizable earnings over the rest of the decade. In current prices, exports of 1 million b/doe would be worth roughly $10 billion annually. We believe, however, that slow progress in reducing oil use will, by 1990, limit potential hard currency earnings from sales of the "saved" oil to less than 30 percent of the prospective 1 million b/doe. 25X1

The Gas Industry

The outcome of efforts to maintain or to accelerate the growth of gas consumption in the power industry 25X1 will be a major determinant of Soviet gas production during this decade. To the extent that the share of gas in power plant fuel use rises, electricity supplies will be more reliable and less costly. Nonetheless, conflicts are likely to deepen between those energy experts promoting a strategy of greater reliance on coal at power plants and the Power Ministry experts who focus on the advantages of using gas. 25X1

We expect that constraints on gas consumption will be the leading factor affecting Soviet gas output through 1990. Gasfield operations and long-distance transportation will be less important because major gasfields are ready to be tapped and the USSR can build the main trunk pipelines necessary to carry this gas. New gas demand by the power industry in 1990 could be 97-123 billion cubic meters, compared with the 117 billion cubic meters consumed in 1980. Consumption 25X1 would fall to the lower end of this range if construction slowed at gas-capable power plants and completion of gas feeder lines to power plants continued to drag. 25X1

Soviet energy experts now view gas as a transition fuel between oil and coal. We believe, however, that after power plant managers and regional network administrators experience the advantages of gas—fewer delivery interruptions, higher quality fuel, and lower operating costs—they will resist a switch to coal. Middle managers in the USSR are masters in the art of foot-dragging. Indeed, the Soviet press has already reported the machinations of a power station manager in 25X1

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Novosibirsk who wanted his plant to use gas instead of slurried coal. If key personnel in the Power Ministry want to delay the planned resurgence of coal as a power plant fuel in the 1990s by obstructing conversion from gas and delaying construction of new coal-fired plants, the return to coal could be delayed substantially, or even derailed. [redacted]

Supply, Reliability, and Costs

Although changes in the composition of power industry fuel supplies now under way and planned could eventually improve the reliability of the power supply, the changeover process will temporarily increase the incidence of disruptions in electricity supply. If the Soviets want to accelerate the rate of substitution in the industry's fuel supply, they will very likely have to convert a number of plants simultaneously, at the risk of increasing the frequency of interruptions in electricity service. The electric power system has very little reserve capacity to bring on line when power plants are out of service during conversion. [redacted]

Eventually, the increased use of gas should make electricity supplies more reliable. As long as the gas pipeline system functions well, gas-fired power plants will not experience interruptions in fuel supplies, and utility customers will be spared the resulting disruptions in electric service. Disturbances are now common at oil- and coal-fired plants because of transportation stoppages and fuel rationing. [redacted]

Moreover, at plants switched to gas from coal or oil, the cost of electricity production should decline. Production costs will be lower because capacity utilization will be higher and gas is less costly than oil on an energy-equivalent basis. At current Soviet prices, fuel costs total nearly 6 million rubles to generate a billion kilowatt-hours at oil-fueled plants but only about half that at gas-fired power stations. [redacted]

There also is a high opportunity cost entailed in using oil instead of gas in power plant boilers. Oil freed from power industry consumption and exported for hard currency has the potential of earning about 15 percent more than gas would on an energy-equivalent basis. [redacted]

In addition, investment requirements for oil production are greater than for gas. For example, a 1979 Soviet text on energy economics indicated that investment requirements for West Siberian oil were 170 percent more than those for West Siberian gas on an energy-equivalent basis. Indications since then show the gap widening. Oil investment needs are soaring because of the increasing difficulty of maintaining production at older fields and the deteriorating reserve quality and remote location of new fields. In 1981 and 1982, the oil industry took nearly 60 percent of all incremental industrial investment in the USSR. Gas industry investment is also rising, but three-fourths of this investment is for pipelines. These pipelines, once built, will continue to operate well into the next century. [redacted]

25X1

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Appendix

Methodology for Projecting Soviet Power Industry Fuel Demand and Fuel Use

In estimating power industry fuel use, our methodology aims at capturing both the flexibility in Soviet power plant fuel-use capability and the constraints in fuel supply to power plants. Our approach parallels actual Soviet behavior in several important respects. We posit minimum use of organic fuels (particularly oil) by (1) simulating generation of as much primary electricity as possible at hydro and nuclear plants, (2) covering the difference between projected demand and primary electricity supply by using the output from organic-fueled plants, and (3) minimizing oil use through direct and indirect substitution of gas and coal, subject to the supply constraints imposed on these fuels by factors such as gas transmission capabilities and coal production problems. 25X1

Electricity and Cogenerated Heat Production

The projection of electricity and cogenerated heat output from all power plants that will use organic fuel is the basis of our estimate of the total fuel requirements of the power industry in 1985 and 1990. The electricity output estimate is a function of effective generating capacity and the capacity utilization rate. The cogenerated heat projections are based on Soviet plans for 1985 and extrapolation of a declining trend to 1990.

Projected Electricity Output 25X1

We estimated gross electricity production in 1985 and 1990 by (1) computing the generating capacity at the end of the previous five-year plan *plus* additions to capacity (for 1981-85 or 1986-90) *minus* retirements and (2) multiplying the result by average annual hours of utilization of capacity. We calculated upper and lower bounds for probable electricity output from thermal power plants in 1985 and 1990 on the basis of alternative assumptions about retirements and capacity utilization. 25X1

The Power Ministry had planned to increase retirements of thermal power plants from 5,200 MW during 1976-80 to 8,000 MW during 1981-85. Below-plan growth of hydro- and nuclear-derived electricity has forced the Soviets to keep many of the obsolete plants running. Less than 2,000 MW of capacity was retired during 1981-82, and we expect that retirements for 1981-85 will total about 2,800 MW. During 1986-90, power plant retirements will need to be accelerated; we estimate plant closures of 4,000 to 7,000 MW. 25X1

The total thermal power plant capacity utilization rate depends not only on plant readiness but also on Power Ministry decisions on reserve margins and Soviet ability to produce electricity at hydro and nuclear plants. The average thermal power plant utilization rate posted during 1975-83 was 5,188 hours out of a theoretical total of 8,765 hours. We calculate electricity output at two rates of utilization. The high rate, 5,250 hours per year, is consistent with improvements to average performance through more gas use and a decision to boost thermal power plant output and hold back on retirements because of shortfalls at hydro and nuclear facilities. The low utilization rate, 5,150 hours per year, reflects factors such as the need to keep older plants operating, diminished plant performance caused by use of low-quality coal, reduced thermal power plant use, and increased retirements because of increased output at nuclear plants. 25X1

Taking these factors into account, we project electricity output in 1985 using the formula *(base capacity + additions − retirements)* × *utilization rate*:

(201,900 MW + 27,500 MW − 2,800 MW) × 5,150 hours = 1,167 billion kWh

(201,900 MW + 27,500 MW − 2,800 MW) × 5,250 hours = 1,190 billion kWh

Similarly, for 1990, we project electricity output:

(226,600 MW + 23,900 MW − 7,000 MW) × 5,150 hours = 1,254 billion kWh

(226,600 MW + 23,900 MW − 4,000 MW) × 5,250 hours = 1,294 billion kWh

We paired the factors of high retirements and low-capacity utilization and low retirements and high-capacity utilization because circumstances such as increased electricity output at nuclear plants would permit both factors in the pairs to be changed. 25X1

Projected Cogenerated Heat Output

Our estimate of the amount of heat to be cogenerated at Soviet power plants in 1985—1,335 million gigacalories (Gcal)—is taken directly from the plan for that year. We project 1990 cogenerated heat output of 1,510 million Gcal on the basis of an estimated annual growth of 2.5 percent during 1986-90. This estimated growth rate reflects the slowdown in additions of new cogeneration power plants and the resulting smaller increment to heat output. 25X1

Total Fuel Use

The Soviets publish statistics annually on the amount of fuel needed to produce an average kilowatt-hour of electricity or an average gigacalorie of cogenerated heat by power plant boilers. The Ministry of Power and Electrification also sets targets for increased fuel efficiencies in both generation of electricity and production of cogenerated heat. The fuel consumption efficiency goals set for 1985 are 319 grams of standard fuel equivalent (SFE) per kWh of electricity and 172.2 kilograms SFE per Gcal of heat. We consider the target for efficiency gains in power generation to be unattainable before the 1990s, but the power industry may come close to achieving the less ambitious goal for cogenerated heat production. [redacted] 25X1

Since 1981 the fuel efficiency of thermal power plants has been 327 grams SFE per kWh (327,000 metric tons SFE per billion kWh). We expect that, at best, the average fuel efficiency in the generation of electricity will improve to 326,000 tons SFE per billion kWh in 1985. Continuing problems with lower quality coal, numerous inefficient older power plants, and a slowdown in additions of more efficient new plants will limit the improvements in fuel efficiency. By 1990 we estimate that efficiency will improve to 323,000 tons SFE per billion kWh, largely because of the changing shares of gas (increased) and coal (decreased) in power industry fuel consumption. [redacted] 25X1

The Soviets expect the efficiency of heat cogeneration to improve from 173 kilograms SFE per Gcal of heat to 172.2 by 1985. We estimate that this goal is reasonable and project an improvement of similar magnitude by 1990. Therefore, we project the fuel efficiency of cogeneration plants at 172.2 thousand tons SFE per million Gcal in 1985, and 171.4 thousand tons SFE per million Gcal in 1990. [redacted] 25X1

Projected Fuel Use in the Generation of Electricity

Total projected fuel use for electricity generation is calculated as the product of (1) estimated total electricity output from thermal power plants and (2) estimated fuel-use efficiency at those plants. However, if we are to compare projected fuel use with past fuel consumption, we need to convert estimated gross electricity production to electricity output net of power station use. This conversion is necessary because the Soviets calculate power industry fuel use in this manner. [redacted] 25X1

In 1980, Soviet thermal power plants used 9 percent of gross electricity output to run equipment at the stations. The Power Ministry estimates that by 1985 power plant use of electricity will increase to 9.1 percent. This projected increase is consistent with data from 1981-83 showing small increases in on-site power plant fuel consumption, primarily at coal-fired plants handling low-quality fuel. By 1990, we expect that the on-site power plant needs for electricity will drop back to 9 percent of gross output as the share of gas-fueled generating capacity increases and the share of coal-fueled capacity decreases. [redacted] 25X1

Using the estimates of gross electricity output and projections of changes in efficiency of fuel use and on-site power use, we calculate the fuel requirements to generate electricity in 1985:

$$1{,}167 \text{ billion kWh} \times .909 \times \frac{326{,}000 \text{ tons SFE}}{\text{billion kWh}} = 346 \text{ million tons SFE}$$

$$1{,}190 \text{ billion kWh} \times .909 \times \frac{326{,}000 \text{ tons SFE}}{\text{billion kWh}} = 353 \text{ million tons SFE}$$

In 1990, fuel needed to generate electricity is calculated:

$$1{,}254 \text{ billion kWh} \times .91 \times \frac{323{,}000 \text{ tons SFE}}{\text{billion kWh}} = 369 \text{ million tons SFE}$$

$$1{,}294 \text{ billion kWh} \times .91 \times \frac{323{,}000 \text{ tons SFE}}{\text{billion kWh}} = 380 \text{ million tons SFE}$$

25X1

Projected Fuel Use in the Cogeneration of Heat

Total projected fuel use in cogenerated heat production is calculated as the product of estimated heat output and estimated fuel-use efficiency in the cogeneration of heat. Although the Soviets measure the efficiency of heat cogeneration net of station use, heat consumption at power plants has a negligible effect on the calculation of fuel needed for heat production. Therefore, we estimate fuel requirements to cogenerate heat in 1985 as:

$$1{,}335 \text{ million Gcal} \times \frac{172{,}200 \text{ tons SFE}}{\text{million Gcal}} = 230 \text{ million tons SFE}$$

For 1990, we project fuel needs:

$$1{,}510 \text{ million Gcal} \times \frac{171{,}400 \text{ tons SFE}}{\text{million Gcal}} = 259 \text{ million tons SFE}$$

25X1

Individual Fuel Supplies

The previous calculations provide likely ranges for total power industry fuel consumption. The amounts of individual fuels (oil, coal, gas, and minor fuels) likely to be consumed will depend on (1) power plant fuel-use capability and (2) the fuels available to the power industry. We ruled out fuel-use capability as a major factor in determining power industry consumption of individual fuels through 1990. Our study of a representative sample of power plants shows that the capability of power stations to use gas or coal would probably exceed the supply of those fuels during 1981-90. Fuel-use capability will be a determinant of fuel types to be consumed only in terms of demand from new capacity. 25X1

The starting point for our estimates of individual fuel supply to the power industry is the consumption of each fuel in 1980. We calculated fuel supply, by type, for all Soviet thermal plants on the basis of total power and cogenerated heat output at all power plants, as well as published Power Ministry statistics on individual fuels used in 1980 at Ministry plants. Although the Ministry plants made up about 90 percent of total capacity and used nearly 88 percent of the fuel consumed in thermal power plants in 1980, the shares of coal and gas burned differed from the shares of these fuels used by all power plants. We adjusted the data to reflect the fact that plants operated solely by the Ministry used about 3 percent more coal and 3 percent less gas than all power plants taken together. 25X1

Supply of Coal to Power Plants

We estimated power industry coal supplies for 1985 and 1990 as (1) supplies received in 1980 *plus* (2) projected new supplies *minus* (3) projected cutbacks in supplies (from coal basins in production decline). Since the quality of coal supplied to power plants has declined, we correspondingly adjusted the energy value of projected coal supply downward. 25X1

For the estimate of power industry coal supply in 1985, the calculations are (in million tons raw coal): 314 (1980 supply) *plus* 33 (increased coal from Ekibastuz, Kuznetsk, and Kansk-Achinsk) *minus* 16 to 23 (decreased supply from Donets, Moscow, and smaller basins in Urals) *equals* 324 to 331. In 1980 the average energy value of coal used in the power industry was 0.5562 tons SFE per ton raw coal. In 1985 we anticipate that the average energy value will decline to 0.5283 tons SFE per ton raw coal. This decline of about 1 percent annually represents an improvement over 1976-80, when coal heat value decreased at an average annual rate of 1.5 percent. Therefore, we calculate the energy value of power industry coal supply in 1985 at 171-175 million tons SFE. 25X1

Projection of power industry coal supply in 1990 is calculated as follows (in million tons raw coal): 314 (1980 supply) *plus* 80 to 110 (increased coal supply during 1981-90 from Ekibastuz, Kuznetsk, Kansk-Achinsk, and several small basins in East Siberia) *minus* 31 to 42 (decreased supply from Donets, Moscow, and smaller basins in Urals) *equals* 352 to 393. In 1990 we expect that the average energy value of power industry coal supply will be about 0.5018 tons SFE per ton raw coal. Thus, power plants will consume an amount of coal equal to 177-197 million tons SFE. 25X1

Supply of Gas to Power Plants

We project power industry gas supply (which consists of natural gas, associated gas, and refinery byproduct gas) in 1985 and 1990 as the sum of four components: (1) preexisting supplies (measured as power industry

consumption at the end of the previous five-year plan), (2) new gas supplies through existing pipelines, (3) gas supplies for new power plants, and (4) new gas supplies for plants converted to gas. 25X1

We considered preexisting gas supplies at power plants in 1985 to be the amount consumed in 1980. We assumed that the preexisting gas supply to power plants for 1986-90 would fall in the range of our projection for total power industry gas use in 1985. In the calculation of "most likely" total 1990 power plant gas supply, we used the midpoint of projected total 1985 gas supply as the estimate of existing gas supply in 1990. 25X1

Since 1980 the elimination of bottlenecks in the gas transmission system has enabled power plants that previously could use gas only part-time to increase this use of gas. From power industry data on monthly gas use published in 1981, we calculated that, if various constraints in gas transmission were eliminated, the power industry could receive up to 17.1 billion cubic meters more gas through existing pipelines. However, some of the bottlenecks will be eliminated only slowly, according to authorities in both the Power Ministry and in gas pipeline construction trusts. We reflected the possibility that most, but not all, gas transmission bottlenecks could be eased by 1985, creating a range for increased consumption of 13.4 to 17.1 billion cubic meters (15.9 to 20.3 million tons SFE). The lower end of the range represents increases to throughput on gaslines connected to only Power Ministry plants, with the postponement to 1990 of improvements to the whole transmission system that would allow the total increase of 17.1 billion cubic meters. 25X1

Gas will be supplied to new power plants of two types—those designed solely for gas use and those that can use either oil or gas. Additionally, many of the plants using gas will be power stations that cogenerate heat. We calculated the gas supply that these new gas-fired plants will need in 1985 and 1990 at two levels. The upper level of gas consumption reflects the assumption that major improvements to the gas distribution system could enable all new gas-capable power plants to operate totally on gas. The lower level of gas consumption reflects the gas distribution bottlenecks that constrain gas use at power plants that can also use oil as fuel. Prior to 1980, the gas distribution constraints were extensive, and many gas-capable plants ran on gas only 25 percent of the year. However, the gas distribution network has been much improved since 1980, and accordingly we estimate that at least 85 percent of the new dual-fueled gas-capable plants will operate on gas. 25X1

Thus, we project gas supplies to new power plants in 1985 in the range of 23.6-26.4 million tons SFE:

4,825 MW (plants using only gas) + 9,916 MW (plants using either gas or oil) × 4,200 hours = 61.9 billion kWh gross output

$$61.9 \text{ billion kWh} \times .909 \times \frac{325{,}000 \text{ tons SFE}}{\text{billion kWh}} = 18.3 \text{ million tons SFE}$$

Plus fuel for cogenerating heat at Tets:

$$2{,}778 \text{ MW (plants using only gas)} + 6{,}996 \text{ MW (plants using either gas or oil)} \times 4{,}200 \text{ hours} \times \frac{1.15 \text{ million Gcal}}{\text{billion kWh}} = 47.2 \text{ million Gcal}$$

$$47.2 \text{ million Gcal} \times \frac{172{,}000 \text{ tons SFE}}{\text{million Gcal}} = 8.1 \text{ million tons SFE}$$

Therefore, total gas use in 1985 by new gas-capable plants, if 100 percent gas supplied, = *26.4 million tons SFE.*

However, if some constraints to gas distribution remain:

4,825 MW + (.85 × 9,916 MW) × 4,200 hours = 55.7 billion kWh gross output

$$55.7 \text{ billion kWh} \times .909 \times \frac{325{,}000 \text{ tons SFE}}{\text{billion kWh}} = 16.5 \text{ million tons SFE}$$

Plus fuel for cogenerating heat at Tets:

$$2{,}778 \text{ MW} + (.85 \times 6{,}996 \text{ MW}) \times 4{,}200 \text{ hours} \times \frac{1.15 \text{ million Gcal}}{\text{billion kWh}} = 42.1 \text{ million Gcal}$$

$$42.1 \text{ million Gcal} \times \frac{172{,}000 \text{ tons SFE}}{\text{million Gcal}} = 7.2 \text{ million tons SFE}$$

Then, total gas use in 1985 by new gas-capable plants, if dual-fueled plants are 85 percent gas supplied, = *23.6 million tons SFE.* 25X1

Similarly, we estimate that gas supplies to new power plants started up during 1986-90 will, in 1990, range between 18.9 and 20.1 million tons SFE:

8,513 MW (plants using gas only) + 4,689 MW (plants using either gas or oil) × 4,200 hours = 55.4 billion kWh gross output

$$55.4 \text{ billion kWh} \times .91 \times \frac{322{,}000 \text{ tons SFE}}{\text{billion kWh}} = 16.2 \text{ million tons SFE}$$

Plus fuel for cogenerating heat at Tets:

945 MW (plants using only gas) + 3,625 MW (plants using either gas or oil) × 4,200 hours × $\frac{1.20 \text{ million Gcal}}{\text{billion kWh}}$ = 23 million Gcal

$$23 \text{ million Gcal} \times \frac{171{,}000 \text{ tons SFE}}{\text{million Gcal}} = 3.9 \text{ million tons SFE}$$

Therefore, total gas use in 1990 by new gas-capable plants, if 100 percent gas supplied, = *20.1 million tons SFE.*

However, if some constraints to gas distribution remain:

8,513 MW + (.85 × 4,689 MW) × 4,200 hours = 52.5 billion kWh gross output

$$52.5 \text{ billion kWh} \times .91 \times \frac{322{,}000 \text{ tons SFE}}{\text{billion kWh}} = 15.4 \text{ million tons SFE}$$

Plus fuel for cogenerated heat at Tets:

945 MW + (.85 × 3,625 MW) × 4,200 hours × $\frac{1.2 \text{ million Gcal}}{\text{billion kWh}}$ = 20.3 million Gcal

$$20.3 \text{ million Gcal} \times \frac{171{,}000 \text{ tons SFE}}{\text{million Gcal}} = 3.5 \text{ million tons SFE}$$

Then, total gas use in 1990 by new gas-capable plants, if dual-fueled plants are 85 percent gas supplied, = *18.9 million tons SFE.* 25X1

The remaining component of power industry gas supply is the fuel to be used at plants converted to gas. During 1981-83, nearly 11,000 MW of capacity was switched to gas use. By 1985 we estimate total conversions of 14,000 to 18,000 MW. During 1986-90, we project that 15,000 to 20,000 MW of capacity could be modified to use gas. *By 1985 the estimated gas supply to converted plants will range from 27.8 to 36.0 million tons SFE, calculated as follows:*

$$14{,}000 \text{ MW} \times 5{,}500 \text{ hours} \times .909 = 70 \text{ billion kWh (output net of plant use)}$$

$$70 \text{ billion kWh} \times \frac{325{,}000 \text{ tons SFE}}{\text{billion kWh}} = 22.8 \text{ million tons SFE}$$

Plus fuel for cogenerated heat at Tets:

$$4{,}620 \text{ MW} \times 5{,}500 \text{ hours} \times \frac{1.15 \text{ million Gcal}}{\text{billion kWh}} = 29.2 \text{ million Gcal}$$

$$29.2 \text{ million Gcal} \times \frac{172{,}000 \text{ tons SFE}}{\text{million Gcal}} = 5.0 \text{ million tons SFE}$$

Thus, total gas use, if 14,000 MW converted, = *27.8 million tons SFE.*

An acceleration of the conversion program could yield:

$$18{,}000 \text{ MW} \times 5{,}500 \text{ hours} \times .909 = 90 \text{ billion kWh}$$

$$90 \text{ billion kWh} \times \frac{325{,}000 \text{ tons SFE}}{\text{billion kWh}} = 29.3 \text{ million tons SFE}$$

Plus fuel for cogenerated heat for Tets:

$$6{,}200 \text{ MW} \times 5{,}500 \text{ hours} \times \frac{1.15 \text{ million Gcal}}{\text{billion kWh}} = 39.2 \text{ million Gcal}$$

$$39.2 \text{ million Gcal} \times \frac{172{,}000 \text{ tons SFE}}{\text{million Gcal}} = 6.7 \text{ million tons SFE}$$

And total gas use, if 18,000 MW converted, = *36.0 million tons SFE.*

25X1

By 1990, power plant conversion to gas will call for new gas supply of 29.8-39.7 million tons SFE, calculated as follows:

$$15{,}000 \text{ MW} \times 5{,}500 \text{ hours} \times .91 = 75.1 \text{ billion kWh}$$

$$75.1 \text{ billion kWh} \times \frac{322{,}000 \text{ tons SFE}}{\text{billion kWh}} = 24.2 \text{ million tons SFE}$$

Plus fuel for cogenerating heat at Tets:

$$4{,}950 \text{ MW} \times 5{,}500 \text{ hours} \times \frac{1.2 \text{ million Gcal}}{\text{billion kWh}} = 32.7 \text{ million Gcal}$$

$$32.7 \text{ million Gcal} \times \frac{171{,}000 \text{ tons SFE}}{\text{million Gcal}} = 5.6 \text{ million tons SFE}$$

Thus, total gas use, if 15,000 MW converted, = *29.8 million tons SFE.*

An acceleration of the conversion program could yield:

$$20{,}000 \text{ MW} \times 5{,}500 \text{ hours} \times .91 = 100.1 \text{ billion kWh}$$

$$100.1 \text{ billion kWh} \times \frac{322{,}000 \text{ tons SFE}}{\text{billion kWh}} = 32.2 \text{ million tons SFE}$$

Plus fuel for cogenerated heat:

$$6{,}600 \text{ MW} \times 5{,}500 \text{ hours} \times \frac{1.2 \text{ million Gcal}}{\text{billion kWh}} = 43.6 \text{ million Gcal}$$

$$43.6 \text{ million Gcal} \times \frac{171{,}000 \text{ tons SFE}}{\text{million Gcal}} = 7.5 \text{ million tons SFE}$$

And total gas use, if 20,000 MW converted, = *39.7 million tons SFE.* 25X1

Supply of Minor Fuels

The minor fuels (shale, peat, and fuelwood/cellulose) contributed 14.3 million tons SFE, or about 3 percent of power industry fuel supply in 1980. The Soviets plan for a small increase to 15.8 million tons SFE by 1985. It is likely that even this modest growth in minor fuels supply could be stretched out until 1990. We, therefore, project that minor fuel supplies to the power industry will range from 14 to 15.8 million tons SFE in 1985 and 1990. 25X1

Calculation of Oil Consumption as a Residual
We projected ranges of oil consumption in 1985 and 1990 by subtracting estimated supplies of coal, gas, and minor fuels from total fuel demand. These calculations are summarized (in million tons SFE) as follows:

	1985 Oil Consumption		1990 Oil Consumption	
	Upper	Lower	Upper	Lower
Total fuel demand	583.0	576.0	639.0	628.0
From which, subtract:				
Coal supply	−171.0	−175.0	−177.0	−197.0
Gas supply	−205.7	−221.1	−254.4	−285.3
Existing supply	138.4	138.4	205.7	221.1
Network gains	15.9	20.3	0	4.4
New plants	23.6	26.4	18.9	20.1
Converted plants	27.8	36.0	29.8	39.7
Minor fuel supply	−14.0	−15.8	−14.0	−15.8
Residual oil demand	**192.3**	**164.1**	**193.6**	**129.9**

(c)

Expressing these projected oil consumption quantities in terms of oil equivalents yields the ranges:
- For 1985—2.29-2.69 million b/doe.
- For 1990—1.82-2.71 million b/doe.

Since oil use in 1980 was 2.54 million b/doe, by 1985 oil demand could fall by 250,000 b/doe or could rise by 150,000 b/doe. For 1990, the projected change in oil consumption ranges from a reduction of 720,000 b/doe to an increase of 170,000 b/doe. 25X1

Table 9
USSR: Thermal Power Plant Capacity and Fuel-Use Capability by Region, 1980 [a]

	Capacity (*megawatts*)		Fuel-Use Capability [b] (*maximum theoretical percent share*)			
	Reported	Identified	Oil	Coal	Gas	Minor Fuels
Total	**192,300**	**176,087**	**84.5**	**51.6**	**38**	**3.9**
Gres (state regional electric power stations)	117,300	117,243	84.2	55.2	32.7	4.8
Tets (heat-electricity centrals)	75,000	58,844	85.1	45.0	48.6	3.5
Regional distribution [c]						
Region I: Northwest		7,296	68	16	55	23
Gres		3,682	63	5	69	26
Tets		3,614	74	27	41	21
Region II: West		11,489	72	3	14	35
Gres		8,485	64	4	NEGL	40
Tets		3,004	95	NEGL	56	23
Region III: South		37,563	98	76	7	NEGL
Gres		33,861	100	79	2	NEGL
Tets		3,702	81	62	44	NEGL
Region IV: North Caucasus		8,080	86	33	67	NEGL
Gres		5,792	100	45	55	NEGL
Tets		2,288	52	3	97	NEGL
Region V: Transcaucasus		5,721	90	12	74	NEGL
Gres		4,043	100	14	67	NEGL
Tets		1,678	67	9	91	NEGL
Region VI: Volga		13,618	92	13	68	NEGL
Gres		4,680	90	7	61	NEGL
Tets		8,939	93	15	72	NEGL
Region VII: Central		27,213	87	35	55	11
Gres		15,239	90	43	41	13
Tets		11,974	81	24	72	7
Region VIII: Urals		19,165	63	77	52	2
Gres		14,335	58	83	59	NEGL
Tets		4,830	78	68	31	7
Region IX: West Siberia		12,244	70	69	30	8
Gres		7,055	60	60	40	NEGL
Tets		5,189	84	83	16	18
Region X: Central Asia		19,929	80	50	51	NEGL
Gres		14,041	76	40	60	NEGL
Tets		5,888	91	75	30	NEGL

Table 9 (Continued)

	Capacity (*megawatts*)		Fuel-Use Capability [b] (*maximum theoretical percent share*)			
	Reported	Identified	Oil	Coal	Gas	Minor Fuels
Region XI: East Siberia		9,382	100	96	10	NEGL
Gres		3,800	100	100	NEGL	NEGL
Tets		5,582	100	93	17	NEGL
Region XII: Far East		4,387	100	92	5	NEGL
Gres		2,230	100	90	10	NEGL
Tets		2,157	100	95	NEGL	NEGL

[a] This table is based on the study of 294 thermal power plants that were in operation by yearend 1980. Plants were selected with several objectives in mind: (1) to describe the thermal power plant inventory as accurately and fully as data allowed and (2) to minimize the amount of data collection and analysis by focusing on the largest plants with the most capacity. The column labeled "Identified" shows the total amount of power plant capacity that we studied. The column labeled "Reported" shows the total Soviet steam-driven power plant capacity as reported in various authoritative sources such as the Soviet statistical yearbook, *Narodnoye khozyaystvo SSSR,* or the Power Ministry's principal published work on the current five-year plan, *Energetika SSSR v 1981-1985 godakh.*

[b] All plants that were studied have been aggregated by their capability to burn a specific fuel irrespective of whether this fuel actually was used. The percentage shares thus reflect individual fuels' *maximum theoretical* share of total capacity, Gres capacity, or Tets capacity. Because this share calculation ignores the effect of all other fuel usage, multiple counting results.

[c] The regional distribution of all the "Identified" capacity is shown in this table. The regional divisions reflect Soviet administrative/economic boundaries. A map identifying the regional divisions follows table 13.

25X1

Table 10
USSR: Estimated New Fuel-Use Capability of Thermal Power Plants, 1981-85 [a]

Fuel	Megawatts	Percent Share
Maximum capacity *(capable of burning indicated fuel as primary or secondary energy source)* [b]		
Total	27,496	100.0
Oil	22,146	80.5
Coal	11,980	43.6
Gas	14,741	53.6
Minor fuels	525	1.9
Estimated fuel use in projected capacity [c]		
Total	27,496	100.0
Oil	250	0.9
Oil/gas	9,916	36.1
Coal/oil	11,980	43.6
Natural gas	3,808	13.8
Byproduct or associated gas	1,017	3.7
Peat	254	0.9
Secondary heat	271	1.0

[a] These data are based on the study of 121 power plants. The Soviets want to add 28,600 megawatts (MW) of capacity at these plants out of a total of 35,200 MW planned new capacity during 1981-85. We project that 27,496 MW will be installed by yearend 1985. We were able to directly identify new-capacity additions at 85 plants representing 20,496 MW. The remaining 7,000 MW of new capacity that we project will be on line by 1985 was extrapolated from new-capacity startups reported during 1981-83 and from the study of power plant construction trends during previous five-year plan periods.
[b] All plants that we project to be in operation by yearend 1985 have been aggregated by their capability to burn a specific fuel regardless of whether this fuel will actually be used. The percentage shares thus reflect individual fuels' *maximum theoretical* share of the total capacity, Gres capacity, or Tets capacity. Because this share calculation ignores the effect of all other fuel usage, multiple counting results.
[c] This distribution summarizes the actual fuel-use capability of the new capacity projected to be in operation by yearend 1985.

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Table 11
USSR: Estimated New Thermal Power Plant Capacity and Fuel-Use Capability by Region, 1981-85 [a]

	Capacity (*megawatts*)		Fuel-Use Capability (*maximum theoretical percent share*) [b]			
	Projected	Identified	Oil	Coal	Gas	Minor Fuels
Total	**27,496**	**20,496**	**80.5**	**45.6**	**51.7**	**1.3**
Gres (state regional electric power stations)	10,557	10,557	80.6	50.6	47.0	NEGL
Tets (heat-electricity centrals)	16,939	9,939	80.4	39.2	57.6	3.1
Regional distribution [c]						
Region I: Northwest		1,150	NEGL	NEGL	100	NEGL
Gres		210	NEGL	NEGL	100	NEGL
Tets		940	100	NEGL	100	NEGL
Region II: West		1,225	100	NEGL	100	NEGL
Gres		0	0	0	0	0
Tets		1,225	100	NEGL	100	NEGL
Region III: South		2,180	61	39	100	NEGL
Gres		850	29	71	100	NEGL
Tets		1,330	100	19	100	NEGL
Region IV: North Caucasus		800	100	NEGL	100	NEGL
Gres		800	100	NEGL	100	NEGL
Tets		0	0	0	0	0
Region V: Transcaucasus		1,010	100	11	89	NEGL
Gres		1,010	100	11	89	NEGL
Tets		0	0	0	0	0
Region VI: Volga		525	71	27	73	NEGL
Gres		0	0	0	0	0
Tets		525	71	27	73	NEGL
Region VII: Central		2,400	80	16	78	6
Gres		900	89	NEGL	100	NEGL
Tets		1,500	74	26	72	9
Region VIII: Urals		680	65	65	18	18
Gres		0	0	0	0	0
Tets		680	65	65	18	18
Region IX: West Siberia		2,239	40	21	79	NEGL
Gres		795	NEGL	NEGL	100	NEGL
Tets		1,444	62	33	67	NEGL

Table 11 (Continued)
USSR: Estimated New Thermal Power Plant Capacity and Fuel-Use Capability by Region, 1981-85 [a]

	Capacity (*megawatts*)		Fuel-Use Capability (*maximum theoretical percent share*) [b]			
	Projected	Identified	Oil	Coal	Gas	Minor Fuels
Region X: Central Asia		5,862	79	67	33	NEGL
Gres		4,662	80	71	29	NEGL
Tets		1,200	78	52	48	NEGL
Region XI: East Siberia		1,175	100	100	NEGL	NEGL
Gres		520	100	100	NEGL	NEGL
Tets		655	100	100	NEGL	NEGL
Region XII: Far East		1,250	100	100	NEGL	NEGL
Gres		810	100	100	NEGL	NEGL
Tets		440	100	100	NEGL	NEGL

[a] These data are based on the study of 121 power plants. The Soviets want to add 28,600 megawatts (MW) of capacity at these plants out of a total of 35,200 MW planned new capacity during 1981-85. We project that 27,496 MW will be installed by yearend 1985. We were able to directly identify new-capacity additions at 85 plants representing 20,496 MW. The remaining 7,000 MW of new capacity that we project will be on line by 1985 was extrapolated from new-capacity startups reported during 1981-83 and from the study of power plant construction trends during previous five-year plan periods.

[b] All plants that we project to be in operation by yearend 1985 have been aggregated by their capability to burn a specific fuel regardless of whether this fuel will actually be used. The percentage shares thus reflect individual fuels' *maximum theoretical* share of the total capacity, Gres capacity, or Tets capacity. Because this share calculation ignores the effect of all other fuel usage, multiple counting results.

[c] The regional distribution of the 20,496 MW of "Identified" capacity is shown in this table. The regional divisions reflect Soviet administrative/economic boundaries. A map identifying the regional divisions follows table 13.

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Table 12
USSR: Estimated New Fuel-Use Capability of Thermal Power Plants, 1986-90 [a]

Fuel	Megawatts	Percent Share
Maximum capacity *(capable of burning indicated fuel as primary or secondary energy source)* [b]		
Total	23,925	100.0
Oil	14,591	61.0
Coal	9,686	40.5
Gas	13,202	55.2
Minor fuels	821	3.4
Estimated fuel use in projected capacity [c]		
Total	23,925	100.0
Oil	216	0.9
Oil/gas	4,689	19.6
Coal/oil	9,686	40.5
Natural gas	7,197	30.1
Byproduct or associated gas	1,316	5.5
Peat	213	0.9
Shale	608	2.5

[a] These data are based on the study of 54 power plants representing 20,925 MW. The remaining 3,000 MW of new capacity that we project will be on line by 1990 was extrapolated from new-capacity startups and analogous construction during previous five-year plan periods.

[b] All plants that we project to be in operation by yearend 1990 have been aggregrated by their capability to burn a specific fuel regardless of whether this fuel actually will be used. The percentage shares thus reflect individual fuels' *maximum theoretical* share of the total capacity, Gres capacity, or Tets capacity. Because this share calculation ignores the effect of all other fuel usage, multiple counting results.

[c] This distribution summarizes the actual fuel-use capability of the new capacity that we project will be in operation by yearend 1990.

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Table 13
USSR: Estimated New Thermal Power Plant Capacity and Fuel-Use Capability, 1986-90 [a]

	Capacity (*megawatts*)		Fuel-Use Capability (*maximum theoretical percent share*) [b]			
	Projected	Identified	Oil	Coal	Gas	Minor Fuels
Total	**23,925**	**20,925**	**61.0**	**40.5**	**55.2**	**3.4**
Gres (state regional electric power stations)	17,751	17,751	53.4	47.8	49.3	4.6
Tets (heat-electricity centrals)	6,174	3,174	86.3	20.2	76.7	NEGL
Regional distribution [c]						
Region I: Northwest		630	NEGL	NEGL	67	33
Gres		630	NEGL	NEGL	67	33
Tets		0	0	0	0	0
Region II: West		960	37	NEGL	37	62
Gres		600	NEGL	NEGL	NEGL	100
Tets		360	100	NEGL	100	NEGL
Region III: South		1,570	62	NEGL	100	NEGL
Gres		850	16	NEGL	100	NEGL
Tets		720	100	NEGL	100	NEGL
Region IV: North Caucasus		270	100	NEGL	100	NEGL
Gres		0	0	0	0	0
Tets		270	100	NEGL	100	NEGL
Region V: Transcaucasus		420	100	NEGL	100	NEGL
Gres		300	100	NEGL	100	NEGL
Tets		120	100	NEGL	100	NEGL
Region VI: Volga		310	68	NEGL	100	NEGL
Gres		0	0	0	0	0
Tets		310	68	NEGL	100	NEGL
Region VII: Central		991	42	31	69	NEGL
Gres		531	39	39	60	NEGL
Tets		460	46	10	78	NEGL
Region VIII: Urals		2,350	32	NEGL	100	NEGL
Gres		2,350	32	NEGL	100	NEGL
Tets		0	0	0	0	0
Region IX: West Siberia		2,924	NEGL	NEGL	100	NEGL
Gres		2,900	NEGL	NEGL	100	NEGL
Tets		24	NEGL	NEGL	100	NEGL

Table 13 (Continued)

	Capacity (*megawatts*)		Fuel-Use Capability (*maximum theoretical percent share*) [b]			
	Projected	Identified	Oil	Coal	Gas	Minor Fuels
Region X: Central Asia		6,790	75	71	28	NEGL
Gres		6,420	75	75	25	NEGL
Tets		370	84	NEGL	73	NEGL
Region XI: East Siberia		3,250	100	100	NEGL	NEGL
Gres		2,810	100	100	NEGL	NEGL
Tets		440	100	100	NEGL	NEGL
Region XII: Far East		460	100	100	NEGL	NEGL
Gres		360	100	100	NEGL	NEGL
Tets		100	100	100	NEGL	NEGL

[a] These data are based on the study of 54 power plants representing 20,925 MW. The remaining 3,000 MW of new capacity that we project will be on line by 1990 was extrapolated from new-capacity startups and analogous construction during previous five-year plan periods.

[b] All plants that we project to be in operation by yearend 1990 have been aggregated by their capability to burn a specific fuel regardless of whether this fuel actually will be used. The percentage shares thus reflect individual fuels' *maximum theoretical* share of the total capacity, Gres capacity, or Tets capacity. Because this share calculation ignores the effect of all other fuel usage, multiple counting results.

[c] The regional distribution of the 20,925 MW of "Identified" capacity is shown in this table. The regional divisions reflect Soviet administrative/economic boundaries. A map identifying the regional divisions follows this table.

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Figure 5
Regions Served by Thermal Power Systems

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Table 14
USSR: Scheduled Power Plant Fuel Conversions, 1981-85 [a]

Plant [b]	Capacity (*megawatts*)	Conversion Date	Old Fuel	New Fuel
Completed				
Syrdar'ya Gres	3,000	1980-81	Oil/gas	Gas
Uglegorsk Gres	2,400	1983	Oil	Gas
Uglegorsk Gres	1,200	1983	Coal	Gas
Nizhnekama Tets	1,100	1984	Oil	Gas
KAMAZ Tets	910	1984	Oil/gas	Gas
Tyumen' Tets	450	1980-81	Peat/oil	Gas
Zuyevka Gres 1	350	1983	Coal	Gas
Novosibirsk Tets 4	412	1981	Coal	Gas
Novosibirsk Tets 2	325	1981-83	Coal	Gas
Riga Tets 2	390	1981-83	Oil	Gas
Baku Tets 1	209	1981-83	Oil	Gas
Baku Krassin Gres	92	1981-83	Oil	Gas
Vitebsk Tets	62	1980-81	Peat/coal	Oil
Blagoveshchensk Tets	60	1981-85	Oil	Coal
Ural'sk Tets	36	1982-83	Oil	Gas
In progress				
Burshtyn Gres	2,400	1984-85	Coal	Gas
Konakovo Gres	2,400	1984-85	Oil/gas	Gas
Tashkent Gres	1,950	1984-85	Oil/gas	Gas
Karmanovo Gres	1,800	1984-85	Oil	Gas
Ladyzhinsk Gres	1,800	1984	Coal/oil	Gas
Ryazan' Gres	1,600	1984-85	Oil	Gas
Stavropol' Gres	1,500	1984-85	Coal/oil	Gas
Kurakhovka Gres	1,460	1984-85	Coal	Gas
Moscow Tets 21	1,180	1984-85	Oil	Gas
Noril'sk Tets 1, 2, 3	925	1984-85	Oil/coal	Gas
Yaroslavl' Tets 1, 2, 3	720	1984-85	Peat/oil	Gas
Novosibirsk Tets 3	700	1984-85	Coal	Gas
Yayva Gres	600	1984-85	Coal	Gas
Minsk Tets 3	434	1984-85	Coal	Gas
Novocheboksarsk Tets 3	320	1984-85	Oil	Gas
Novokuybyshevsk Tets	255	1984	Oil	Gas
Khar'kov Tets 5	240	1984-85	Coal	Gas
Perm' Tets 9	220	1984-85	Oil	Gas
Kizel Gres 3	117	1984-85	Coal	Gas
Orsha Tets	50	1984-85	Peat/coal	Oil
Polotsk Tets	50	1984-85	Peat/coal	Oil

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[a] This table identifies all the power plants that [redacted] are part of the 1981-85 fuel conversion program. See table 7 for a summary view of fuel conversion.

[b] Plant capacity may differ from data cited elsewhere because this listing shows only power plant capacity affected by fuel conversion. The Uglegorsk Gres is listed twice because of separate oil and coal fuel arrangements at the plant. 25X1

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